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Assessment of 4X Haddock in 1998 and the first half of 1999.

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Abstract

Landings of 4X haddock in 1998 were 7,843t against a TAC of 8,100t. The TAC for 1999 was 8,100t and was prorated to 9,800t for a 15 month period ending March 31, 2000. Landings in the first half of 1999 were 2,313t. The 1993 and 1994 year-classes made up a substantial proportion of the catch-at-age in 1998 and in the first half of 1999. Catches in the summer research vessel survey were high throughout the stock area. Fish condition is increasing but is below the long-term mean. Mean fish size is currently at low levels. All age classes are widely distributed, a condition usually associated with high abundance in this resource. The results of a resource abundance survey, conducted by the ITQ fleet in cooperation with DFO Science for the fifth year in 1999, were used in the assessment. Both the 1993 and 1994 year-classes are strong and the 1996 year-class is above average. The 1997 year-class may also be above average and catches of age 0 and 1 year old haddock in the 1999 research vessel and ITQ surveys suggest the 1998 and 1999 year-classes may also be strong. Spawning stock biomass has increased from a low of 18,000t in 1990 to 40,000t in 1998 but will decrease to 35,000t in 1999. The $F_{0.1}$ yield in the 12 month fishing year starting April 1, 2000 would be 8,200t. Spawning stock biomass would increase in 2001 to 39,000t.

Résumé

Les débarquements d'aiglefin en provenance de 4X ont atteint 7 843 t en 1998, le TAC étant fixé à 8 100 t. Le TAC de 1999, de 8 100 t, a été corrigé au prorata à 9 800 t pour la période de 15 mois prenant fin le 31 mars 2000. Les débarquements de la première demie de 1999 ont atteint 2 313 t. Les classes d'âge de 1993 et 1994 formaient une partie appréciable des prises selon l'âge de 1998 et de la première demie de 1999. Les captures réalisées dans le cadre du relevé d'été par navire de recherche ont été importantes dans toute la zone du stock. La condition des poissons s'améliore mais demeure inférieure à la moyenne à long terme. La taille moyenne des poissons est faible. Toutes les classes d'âge sont largement réparties, ce qui correspond généralement à un niveau d'abondance élevé pour cette ressource. Les résultats d'un relevé d'abondance, réalisé par la flottille à QIT en collaboration avec les Sciences du MPO, pour la cinquième année en 1999, ont été utilisés pour la présente évaluation. Les classes de 1993 et 1994 sont fortes et celle de 1996 est supérieure à la moyenne. La classe de 1997 pourrait aussi être supérieure à la moyenne et les captures d'aiglefins d'âges 0 et 1 au moment du relevé par navire de recherche et de celui de la flottille QIT en 1999 portent à croire que les classes de 1998 et 1999 pourraient aussi être importantes. La biomasse du stock de géniteurs a augmenté, d'un minimum de 18 000 t, en 1990, à 40 000 t en 1998, mais déclinera à 35 000 t en 1999. Le rendement au niveau $F_{0.1}$ au cours des 12 mois de pêche débutant le 1er avril 2000 devrait être de 8 200 t. La biomasse des géniteurs devrait augmenter à 39 000 t en 2001.

Introduction

This document contains an evaluation of the NAFO Division 4X haddock stock for 1998 and the first half of 1999. As in the previous assessment of this stock (Hurley et al. 1998), haddock caught by Canadian fishermen in NAFO Division 5Y are included in the analysis. Haddock in the Bay of Fundy area grow faster than haddock on the Scotian Shelf in 4X. As a result, haddock landings from 4Xmnop and 4Xqrs/5Y are handled separately and separate age/length keys are used for the two areas, designated as Scotian Shelf and Bay of Fundy stock components respectively (Figure 1). Similarly haddock catches from the research vessel survey strata 470-481 and 482-495 are handled separately, as Scotian Shelf and Bay of Fundy components (Figure 2). In 1999, the fishing year was changed from January to December to April to March. The TAC of 8,100t established for the 12-month fishery in 1999 was extended to 9,800t for the 15-month period ending March 31, 2000, based on the proportion of landings in the first quarter of the year over the last 10 years.

This assessment includes the research vessel survey data in the current year 1999, together with commercial landings data for the first half of the year and commercial samples of those landings, to determine stock status in the current year and to make yield projections for the fishing year 2000/1. The results of an industry survey conducted in 1995-99 were also used in the assessment.

Description of the Fishery

Nominal Catches

The long-term (1948-98) reported annual landings of haddock in NAFO Division 4X average about 19,000t. Landings exceeded 30,000t during the mid- to late 1960s and again during the early 1980s (Table 1 and 2, Figure 3). Landings declined subsequently and have been below the long-term average since 1984. Landings reached 6,800t in 1989 when it was recommended that the fishery be maintained at the lowest possible level and the mobile gear fishery was closed in mid-season. Landings increased from 1989 to 10,530t in 1992 under a Management Plan that called for a by-catch fishery only. A TAC of 6,000t was implemented in 1993 and landings in that year were 6,968t. Landings in 1994 were 4,406t, the lowest level observed in recent history, under a quota of 4,500t and stringent fishing plans. Quotas for 4X haddock have increased slightly in the past several years. The TAC in 1998 was 8,100t and total reported landings were 7,843t (Table 2). The 1999 TAC was set at 8,100t and was subsequently changed to 9,800t for a 15 month period ending March 31, 2000, based on proration from the average first quarter landings over the last decade. This 15-month quota was necessary to change the fishing year to an April 1 starting date. Landings for the first half of 1999 were 2,313t.

The by-catch of 4X haddock in the foreign silver hake fishery has been less than 50t (Table 2). The co-ordinates of the Small Mesh Gear Box were re-defined in 1994,

resulting in a shift in the Box to the east and to deeper water. This change and the introduction of grates have resulted in a reduction in the groundfish by-catch in this fishery. The 4X haddock by-catch has been less than 10t since and was negligible in 1999.

The domestic fishery was dominated by the mobile gear sector between 1977 and 1989 (Table 3). Between 1990 and 1994, the fixed gear sector took a larger proportion of the landings; however the proportion taken by the mobile gear sector has increased since and was 67% in 1998.

Inshore mobile gear (<65ft) landings were 5,154t in 1998 (Table 3) while landings by the offshore mobile gear fleet were 80t. Fixed gear landings are made primarily by longliners <65ft but some haddock is landed by handline and gillnet. Longline landings were 2,421t while handline and gillnet landings were 137t and 50t respectively.

Mobile gear sector haddock landings in the first quarter of 1998 were twice those of 1997, and the highest since 1989 (Table 4 and 5). This was a result of directed fishing for haddock off the back of Browns Bank and along the edge in February, March and early April (Figure 4). This occurred due to an unusual concentration of haddock in an area and depth where haddock would usually not be encountered, and also favourable market conditions and increased haddock allocations. Landings then dropped off in May and June but picked up again in July. The proportion of mobile gear sector haddock landings from 4Xs and 5Y has been increasing in recent years. Landings from this area were high again in 1998 but lower than the peak in 1997.

As in recent years, there was almost no winter longline fishery in 4Xno in 1998; however there were sustained low levels of fishing through the winter and spring (Table 4, Figure 4). Fishing started to increase in June but like 1997 did not intensify until July. The handline fishery was a month late starting but extended into September in 1998. The gillnet fishery started about a month earlier.

In 1999, the mobile gear fleet directed for haddock in January but landings through the remainder of the first half were more like recent years (Table 4 and 5, Figure 5). Longline landings were low throughout the first half of 1999 and handline and gillnet fishing did not start until June.

Allocations and Management Actions

Quota allocations and management actions for 4X haddock in recent years have been quite complicated and are described in detail by Annand and Hansen (1994, 1995, 1996, 1997) for 1993 to 1996 respectively and in previous assessment documents for this stock. Since 1995, all fleets have been required to submit Conservation Harvesting Plans prior to fishing. Dockside monitoring continues to be the predominant method for collection of landings and effort data. The mobile gear ITQ fleet and the offshore and midshore EA

fleets continued with 100% weighout of all landings while the generalist fleet was subject to 50% weighout. The fixed gear <65' were placed under a minimum of 20% weighout distributed on a random basis.

The spawning closure on Browns Bank was in place for all groundfish gears February 1 to June 15. Small fish protocols have been in place since 1994 and have resulted in the closure of Roseway Bank to fixed gear in several years subsequently. Roseway Bank was not closed in 1998, to allow a detailed study of size composition of catches in the area. The mobile gear sector encountered large numbers of small haddock in deep water to the southeast of Browns Bank in March 1998, which resulted in a small fish closure. Browns Bank was closed to all gear sectors in late June 1998 due to small haddock. There were no small fish closures in the first half of 1999.

In 1997, the fixed gear <45' adopted a community structure for quota groups and were divided into seven geographic management boards. The fixed gear 45-65' operated independently of the fixed gear <45'. Within the community quota framework, the practice that started in 1997 of either equal shares or sharing arrangements based on catch history within community groups was much more widespread in 1998 and continued in 1999. Quota allocations, closures and trip limits were managed within the Management Boards. Community management and sharing arrangements have resulted in a shift in the timing of the fixed gear fishery.

Additional Information about the Fishery

During industry consultations in 1998, most fishermen indicated they felt haddock abundance was good throughout most of the stock area, but not in the eastern portion of 4X. Roseway Bank and "the Gully", between Browns and Georges Banks, were mentioned as hotspots. It was observed that haddock were generally small. Haddock taken by handliners were still small in 1998 but fish size had improved over 1997. The fixed gear sector reported that they were able to avoid small fish, in comparison to the previous couple of years. It was felt that discarding of small haddock in the longline fleet was reduced in 1997 and had decreased further in 1998. The absence of dogfish was noted and some indicated they were able to fish in inshore areas that they would usually avoid because of dogfish. The mobile gear sector encountered large numbers of small haddock in deep water to the southeast of Browns Bank in March, which resulted in a small fish closure. This concentration of fish was considered unusual.

Issues concerning haddock were rarely raised during industry consultations in 1999. Cod, pollock, and white hake were usually the concern. The small fish problem the mobile gear encountered on the back of Browns in 1998 did not re-occur. Mobile gear boats have generally been able to maintain an appropriate species mix, but have had to avoid cod. Some inshore fixed gear groups have had problems maintaining a species mix that matched their quotas. Dogfish were present again this year and many fixed gear boats

that fished inshore last year moved to deeper water in 1999. Discarding of small haddock was low because plants were paying a good price for small haddock in 1999.

Data

Size and Age Composition of the Catch

The size composition of 4X haddock landings from 1991-98 is shown in Figure 6. There has been an increase in the mean length of mobile gear landings from 48.3cm in 1990 since the introduction of square mesh and ITQs in the early 1990s. Mean length in mobile gear landings dropped from 54.7cm in 1995 to 51.6cm in 1996, then to 49.8cm in 1998 and to 49.2cm in the first half of 1999. Mean length in fixed gear landings decreased from 54.1cm in 1990 to 49.4cm in 1993 and has remained relatively stable since. The size compositions of mobile and fixed gear landings in 1998 were comparable.

As a routine check, an inter-reader comparison was conducted using a subset of otoliths read for this assessment. Otoliths were selected from the third and fourth quarter of 1998 and first and second quarter commercial samples and from the 1999 research vessel survey. A pairwise comparison of ages from the primary and secondary agers showed high precision and little bias, with an overall coefficient of variation of 2.29 and 3.07 for the commercial and survey samples respectively (Figure 7). Although there was a slight bias at older ages, the sample size at those ages was small and the results were considered acceptable.

Commercial sampling data were used to construct a catch-at-age for 1998 and the first half of 1999 as in previous assessments of this resource. Samples were aggregated by area, quarter and gear type, and seasonal length/weight parameters derived by O'Boyle et al. (1983) were used. The gear and quarter aggregations are shown in Table 7 and 8. In 1998, mobile gear samples from the third and fourth quarters in 4Xmnop were aggregated. Longline samples from 4Xmnop and 4Xqrs5Y were aggregated in the first two quarters of 1998. In 1999, insufficient fixed gear samples were available due to the late start of fishing and the few landings to sample. Therefore the longline length frequencies were combined with mobile gear length frequencies from the same period and the age/length key from the mobile gear samples was used. The resulting catch-at-age is shown in Table 9.

The 1993 and 1994 year-classes make up a substantial proportion of the 1998 catch-at-age; however a comparison of the predicted contribution of these year-classes to the observed catch-at-age indicates the 1994 year-class at age 4 and to a lesser extent the 1993 year-class at age 5 are under-represented in the catch and that ages 6 and 7 were caught in larger numbers (Table 10). In 1999, age 4 to some extent and age 5 are again under-represented in the catch. This could be due to an inappropriate selectivity used in

the projection last year, to discarding, avoidance of small fish or to the fact that a half-year catch-at-age is being used.

Commercial weights-at-age from 1970-99 show what appear to be two separate regimes, with a period of relatively high weights-at-age through the late 1970s and early 1980s, particularly at older ages (Table 11, Figure 8). In the mid 1980s, commercial weights-at-age drop to lower levels. The reason for this change is unknown. There is a decreasing trend in recent years, and the 1998 weights-at-age are all less than the mean for 1988-97, the period of lower weights. The 1999 values are for the half-year and are lower than recent full year values.

Research Vessel Surveys

A summer groundfish research vessel survey of the Scotian Shelf and Bay of Fundy has been conducted in July since 1970. The stratification scheme used in this stratified random survey design is shown in Figure 2. The vessel conversion factor of 1.2 was used for the *A.T. Cameron* surveys (Fanning 1985). Mean number per tow by stratum for 4X haddock are shown in Table 12. Most strata are at or near the long-term mean for the stratum and many were above the long-term mean, especially Browns Bank (stratum 480).

Mean number per tow of 4X haddock in 1999 was 111 relative to the long-term mean of 45 (Figure 9). Mean weight per tow was 36kg the same as the long-term mean. Catch rates in the Scotian Shelf strata were high, 192 haddock per tow relative to the long-term mean of 62, and 52kg per tow relative to the long-term mean of 42kg. Catch rates in the Bay of Fundy strata were much lower, 31 haddock per tow relative to the long-term mean of 28, and 20kg per tow relative to the long-term mean of 28kg.

The size composition for the 1999 research vessel survey shows catch numbers-at-length corresponding to ages 0 and 1 to be very high (Figure 10). Catches were above average at lengths up to 50cm. Catches at sizes corresponding to ages 0 and 1 were widespread (Figure 11).

Mean age composition for the 1999 survey shows numbers-at-age 0 to be an order of magnitude higher than previous seen in the survey series (Table 13). Numbers-at-age 1 are only exceeded by the 1994 year-class at age 1. Numbers-at-age are above the long-term mean for all ages except age 2. The 1993 and 1994 year-classes at ages 6 and 5 are still above average but not to the same extent as in earlier years. All ages are more abundant in the Scotian Shelf strata than in the Bay of Fundy strata (Figure 12).

Mean length-at-age of haddock caught in the Scotian Shelf strata of the summer research vessel survey decreased through the mid to late 1980s (Table 14, Figure 13). Some recovery occurred during the late 1980s and early 1990s but not to the sizes of the earlier period. Mean length-at-age has been decreasing since the mid 1990s. Ages 2 and older

in 1999 are below the long-term mean and ages 5-9 are at the smallest length-at-age in the survey series. Mean length-at-age of haddock caught in the Bay of Fundy strata is larger than in the Scotian Shelf strata. The same general trend in mean length-at-age is present in the Bay of Fundy, although the range is less (Table 15, Figure 14). Mean length-at-age has been decreasing since the mid 1990s and ages 4 and older in 1999 are below the long-term mean. Ages 5-7 are the smallest in the survey series.

Similar trends have occurred in mean weights-at-age (Table 16 and 17, Figure 14). Ages 2-9 in both areas in 1999 are below the long-term mean and ages 5-9 in the Scotian Shelf strata and ages 5-7 in the Bay of Fundy are the lowest in the survey series. Mean weights-at-age for the entire survey area (strata 470-495) used in the SPA are shown in Table 18.

Condition is the relative weight of the fish for their length (i.e. their plumpness). An index of condition, the predicted weight of a haddock at a given length, was calculated from the annual length/weight relationship from the summer research vessel surveys. Indices were calculated for 35 and 50cm (Tables 19 and 20, Figure 15). While these indices were variable, they indicated that condition had decreased since the late 1980s and reached a minimum in both the Scotian Shelf and the Bay of Fundy strata in 1995. Condition has increased since but is still below the long-term mean. Low condition may be an indicator of poor health; however the cause of low condition in this stock is uncertain and the significance of this low condition is unknown.

Several spatial indicators for the 4X haddock stock were calculated from the summer research vessel survey from strata 470-495. The proportion of annual survey sets where a species occurs (non-zero sets) is a measure of how widely a stock is distributed within its historical geographic range. This index has been increasing throughout the 1990s and is presently at a record high, indicating that the resource is very widely distributed (Figure 16a). The proportion of the historical stock area encompassing 75% of the annually estimated survey biomass is a measure of resource concentration. This index is presently high, indicating that the resource is evenly dispersed (Figure 16b).

Industry Survey

The ITQ fleet in co-operation with DFO Science has conducted a trawl survey of the 4X area since 1995 during July, the same time that the DFO research vessel *Alfred Needler* conducts the annual summer groundfish survey. The ITQ survey was designed to cover the entire 4X area, including the inshore area off southwest Nova Scotia that the *Alfred Needler* is unable to survey. This inshore area has become a major fishing area for the mobile gear sector in recent years, and as much as 20% of 4X haddock landings by mobile gear have been caught in this area.

This survey has been conducted by three draggers (<65 ft) equipped with standardised gear with the same size codend liner as the research vessel. A fixed station design, based upon the research vessel survey strata, is used and standardised tows are made. Sampling

of catches is conducted by Fisheries Observers and length frequency samples are taken for cod, haddock, pollock, winter flounder and redfish. Further details are summarised in O'Boyle et al. (1995). Results of the 1995-97 surveys were reported in detail by Hurley et al. (1996, 1997, 1998).

A total of 184 standardised fishing sets were made in 1999 (Figure 17). There were 29 tows in the area inshore of the traditional research vessel strata. Catch rates by stratum from the two surveys in 1998 are compared in Tables 21 and 22. As in previous years, catch rates were generally but not always higher in the ITQ survey. Catch rates in the inshore area were high. There were also differences in the size compositions between the two surveys in 1999, and between the inshore area and the adjacent strata (481,485,490) (Figure 18). Overall the research vessel survey caught more haddock <14cm, while the ITQ survey catches were larger from 14-48cm. The research vessel survey caught more haddock at lengths >48cm. Comparison of catches by the two surveys in the strata adjacent to the inshore area shows the same pattern, with catches <18 and >50cm higher in the research vessel survey. Catches by the ITQ survey in the inshore area were higher than in the adjacent strata at lengths <40cm, but only slightly lower at larger lengths.

Arithmetic mean catch rate trends calculated for ITQ survey tows in the Scotian Shelf (470-481) and Bay of Fundy (482-495) stratum groups were comparable to trends from the research vessel survey (Figure 19). Catch rates in the inshore area have increased over the last three years but have remained relatively stable in the Bay of Fundy (Figure 20).

Total numbers-at-length for the three areas from the ITQ surveys (Table 23) were converted to total numbers-at-age using the age/length keys from the research vessel surveys (Table 24). The age/length keys for the Bay of Fundy strata were used to convert the inshore catches. The resulting combined catch-at-age was used as an index of haddock abundance. As in the research vessel survey, catches are generally higher in the Scotian Shelf strata, particularly at ages 1 and 2. Catches at ages 0 and 1 were high in all three areas.

Estimation of Parameters and Assessment Results

A traditional age-based SPA was conducted using the ADAPT framework (Gavaris 1988). The model used is as follows:

Parameters:

Survey numbers at mid-year $N_{i,1999}$ i = 2-7

Calibration coefficients $q_{1,i}$ i = ages 2-7 for July RV survey

$q_{2,i}$ i = ages 2-7 for ITQ survey

Structure Imposed:

Error in catch assumed negligible
Partial selection fixed for ages 1 and 8-10 in 1999
F on oldest age (10) set as average F of ages 2-7 adjusted by the relative selectivity of age 10 in 1999
No intercepts were fitted
M = 0.2 for all ages

Input:

$C_{i,t}$ i = 1-10; t = 1970 to 1999 - catch-at-age for entire year (half year for 1999)
$J_{i,t}$ i = 2-7; t = 1970 to 1999 - July RV survey index
$ITQ_{i,t}$ i = 2-7; t = 1995 to 1999 - ITQ survey index

Objective function:

Minimise $\{ \Sigma\Sigma (\ln J_{i,t} - \ln q_{1,i} N_{i,t})^2 \} + \{ \Sigma\Sigma (\ln ITQ_{i,t} - \ln q_{2,i} N_{i,t})^2 \}$

Summary:

Number of observations: 180 for July RV (6 ages by 30 years)
30 for ITQ (6 ages by 5 years)
Number of parameters: 18, 6 ln Ns estimated by NLLS, 12 qs algebraically

age	1	2	3	4	5	6	7	8	9	10
starting selectivity	.0001	.033	.118	.453	.884	.972	1.00	1.00	1.00	1.00
new selectivity	.0001	.004	.055	.205	.503	.814	.918	1.00	1.00	1.00

The minimisation technique used was a non-linear least squares (NLLS) gradient technique (the Marquardt algorithm). The NLLS technique is a compiled version of ADAPT written in ACON.

The SPA input data, commercial catch numbers-at-age, research vessel survey stratified mean numbers-at-age per tow, and ITQ survey total numbers-at-age, are shown in Tables 12, 13 and 24 respectively. A new selectivity was calculated by taking the average from the three most recent years, from successive iterations of the model. This resulted in a decrease in selectivity at ages up to age 8, with the largest changes at ages 4 and 5. This seems reasonable, given the under-representation of ages 4 and 5 in the catch-at-age compared to the numbers predicted in the previous assessment, and given the decreases in size-at-age that have occurred. The resulting estimates of fishing mortality, population numbers and biomass, and residuals are shown in Table 25 and Figure 21. Also shown in Table 25 are summary statistics of the overall fit of the model and the bootstrap bias correction results based on 1,000 replicates. The research vessel survey calibration coefficients had CVs of 11% and bias of less than 1%. The ITQ survey calibration coefficients had CVs in the range of 28-30% and larger bias also; however this is due largely to the short time series. Bias in the population estimates was less than 1%.

As with previous assessments of this resource, the residuals show some strong year effects, with positive residuals at all ages in some years and negative residuals at all ages in other years; however these patterns are less extreme than in previous assessments (Hurley et al. 1996, 1997). The inclusion of the ITQ survey improved the overall fit, relative to an SPA using the research vessel survey alone, and resulted in slightly lower population numbers.

Past assessments of this resource have shown a strong retrospective pattern, where exploitation is under-estimated and population abundance is over-estimated in the current year, relative to when additional data are available in subsequent years. The retrospective pattern in this assessment is relatively good (Figure 22). Estimates of total mortality calculated from research vessel surveys were comparable with estimates of fishing mortalities from the SPA (Figure 23).

The exploitation rate on ages 5-7 has been higher than the target (20%, $F_{0.1}$=0.25) since the early 1970s (Figure 24). Exploitation decreased from approximately 50% in the early 1980s to close to the target level through the late 1980s and early 1990s. It dropped below the target in 1994-97 and increased to slightly above the target in 1998.

Spawning stock biomass, calculated as population biomass at ages 4 and older, decreased from a peak in 1979 of 66,000t to a low of 18,000t in 1990 (Table 25, Figure 25). It has increased to 40,000t in 1998 but has decreased to 35,000t in 1999.

Except for the 1987 and 1988 year-classes, recruitment of the 1983-92 year-classes was below average (Figure 25). The 1993 and 1994 year-classes are both strong and the 1996 year-class is above average. This assessment estimates the 1997 year-class to be very strong. The research vessel survey and the ITQ survey suggest this year-class is average to above average in abundance. There appears to be no relationship between spawning stock biomass and recruitment over the biomass range observed (Figure 26).

It was shown that a retrospective effect exists between observations of year-classes at early ages in the current year and subsequent estimates, particularly for large year-classes (Hurley et al. 1996, 1997). A Gompertz model fit through contemporaneous and converged estimates at ages 4 and 5 was used last year to adjust estimates of the 1993 and 1994 year-classes in the stock projection (Hurley et al. 1998). This analysis indicates there is a tendency to over-estimate large year-classes at all ages in the calibration block (Figure 27). A Gompertz model fit through research vessel abundance estimates in one year with estimates for the same year-class in the subsequent year (adjusted for natural mortality) show the same tendency, suggesting that the phenomenon is not solely a result of the SPA model (Figure 28). A comparison of the ratio of contemporaneous to converged estimates over time indicates there is a time element to this phenomenon also (Figure 29).

A closer examination of the data shows that this relationship at older ages is largely determined by the 1979 to 1982 year-classes (particularly the 1980 year-class), a period when the retrospective pattern is particularly strong for this assessment (Figure 21). If one examines successive retrospective estimates of year-class size at age 1 in recent years (Figure 30), it can be seen that the 1993 and 1994 year-classes were initially over-estimated but that these estimates are stabilizing as the number of estimates in the calibration increases, as one would expect. The adjustments applied to these year-classes in the previous assessment are not appropriate at ages 5 and 6.

Population numbers in the upper right-hand cell of the calibration block (age 2 in 1999, in this case) are not well estimated. This assessment estimates this year-class to be very strong. A Gompertz model fit through contemporaneous vs. converged estimates of abundance at age from retrospective SPAs suggest the 1997 year-class at age 2 in 1999 be reduced from 41 million, as estimated by the SPA, to 24 million. It is felt that this value is a more reasonable estimate to use for yield projections than either the unadjusted value from the SPA or geometric mean recruitment. Geometric mean recruitment from the period 1983-95 (15 million) was used for the 1998 and subsequent year-classes in the projection. Due to the decreasing trends in size-at-age in recent years and the differences between commercial and research vessel survey weights-at-age, the 1999 research vessel survey weights-at-age were used to calculate population biomass and the 1998 commercial weights-at-age (1999 values are from half-year catches) were used to calculate yield in the projection. Catches in 1999 and the first quarter of 2000 were assumed to be 8,100t and 1,700t respectively.

Outlook

Projected yield for the 12 month fishing year starting April 1, 2000 at the target exploitation rate (20%, $F_{0.1}$=0.25) would be 8,200t (Figure 31). Of this yield, 63% would come from the 1993 and 1994 year-classes. Spawning stock biomass would peak in 2001 at 39,000t and decrease to 37,000t at the beginning of the 2002 fishing year.

Year	F	Yield (t)	Population Biomass (t)	Spawning Biomass (t)	
1999	0.274	8100	45122	34994	Bridging Year
2000	0.043	1700	48275	39301	Bridging Quarter
April 1st starting date					
2000	0.250	8200	45981	36405	
2001	0.250	8590	45277	39069	
2002	0.250	8599	43597	37388	

Risk analysis indicates that at a yield of 8,200t (which corresponds to a 50% risk of exceeding $F_{0.1}$) in the fishing year 2000 (Figure 32), the spawning stock biomass has an 18% probability of decreasing for the 2001 fishing year. The probability of spawning stock biomass decreasing for the 2001 fishing year increases to 50% at a yield of 10,900t.

Projected yield was calculated using commercial weights-at-age. Weights-at-age in this resource have been declining since the mid 1990s. If this trend continues, then yield will be over-estimated. If there was a shift in the proportion of landings from the Bay of Fundy to the Scotian Shelf where growth is slower, this would also result in yield being overestimated.

This assessment indicates the resource is rebuilding, due to a number of strong year-classes and to recent exploitation levels at or slightly below the target level. Spawning stock biomass is near average levels but will decrease until further strong recruitment occurs. There are indications of good recruitment in 1999 as evidenced by the widespread occurrence of age 0 and 1 year old haddock in the surveys. All age classes are widely distributed, a condition usually associated with high abundance in this resource. Fish condition is increasing but is below the long-term mean. Mean fish size is currently at low levels.

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Table 1. Reported nominal catch (t rounded) and TAC of haddock from NAFO Division 4X.

	Catch	TAC
1960	15800	
1961	17918	
1962	18032	
1963	24461	
1964	36049	
1965	29166	
1966	43349	
1967	37896	
1968	32602	
1969	30703	
1970	18072	18000
1971	17592	18000
1972	13483	9000
1973	13106	9000
1974	13378	0
1975	18298	15000
1976	17498	15000
1977	21281	15000
1978	27323	21500
1979	25193	26000
1980	29210	28000
1981	31475	27850
1982	25729	32000
1983	27405	32000
1984	21156	32000
1985	16131	15000
1986	15555	15000
1987	13780	15000
1988	11272	12400
1989	6800	4600
1990	7556	4600
1991	9826	0
1992	10530	0
1993	6968	6000
1994	4406	4500
1995	5669	6000
1996	6245	6500
1997	6527	6700
1998	7843	8100
1999*	2313	8100

* - Landings to June 30, 1999

Table 2. Reported nominal catch (t rounded) of haddock from NAFO Division 4X (Canadian landings include 5Y) by country. The numbers in brackets represent the number of commercial samples collected in that year.

Year	Canada (MQ)	Canada (NFLD)	USA	USSR	Spain	Other	Total	TAC
1970	16050 (26)	-	1638	2	370	12	18072	18000
1971	16493 (29)	-	654	97	347	1	17592	18000
1972	12593 (36)	-	409	10	470	1	13483	9000
1973	12687 (30)	-	265	14	134	6	13106	9000
1974	12586 (25)	-	660	35	97	-	13378	-
1975	16139 (56)	-	2111	39	7	2	18298	15000
1976	16426 (45)	-	972	-	95	5	17498	15000
1977	19619 (79)	-	1648	2	-	12	21281	15000
1978	26045 (62)	114	1135	2	-	27	27323	21500
1979	24837 (49)	268	70	3	-	15	25193	26000
1980	28807 (56)	71	257	38	-	37	29210	28000
1981	30877 (82)	117	466	-	-	15	31475	27850
1982	24843 (92)	28	854	-	-	4	25729	32000
1983	26843 (119)	44	494	17	-	7	27405	32000
1984	20927 (97)	23	206	-	-	-	21156	32000
1985	16105 (86)	-	25	-	-	1	16131	15000
1986	15507 (78)	-	38	10	-	-	15555	15000
1987	13763 (82)	-	17	-	-	-	13780	15000
1988	11217 (79)	-	2	53	-	-	11272	12400
1989	6794 (43)	-	1	5	-	-	6800	4600
1990	7504 (71)	-	32	17[2]	-	3[2]	7556	4600
1991	9772 (81)	13	-	38[2]	-	3[2]	9826	-
1992	10508 (89)	5[1]	-	-	-	17[2]	10530	-
1993	6947 (86)	-	-	-	-	21[2]	6968	6000
1994	4405 (68)	-	-	-	-	1[2]	4406	4500
1995	5660 (78)	-	-	-	-	9[2]	5669	6000
1996	6237 (84)	-	-	-	-	8[2]	6245	6500
1997	6519 (87)					8[2]	6527	6700
1998	7842 (86)					1[2]	7843	8100
1999	2313 (47)						2313	8100

1 = NAFO Circular Letters 2 = Observer Program Data * = 1999 Data only for quarters 1 and 2

Table 3. Reported nominal catch (t round) of haddock from NAFO Division 4X landed in the Maritimes split by tonnage class and gear type. The numbers in brackets represent the mean weight landed per age/size sample collected.

	Tonnage Class							
	TC 1-3				TC 4+			
Year	MG (OT)	FG (LL)[1]	Misc.[2]		MG (OT)	FG (LL)	Misc.	Total
1970	5510 (1377)	3393	492		6503 (296)	113	0	16012
1971	4744 (949)	3598 (1199)	260		7712 (367)	94	0	16407
1972	2929 (732)	4472 (447)	357		4742 (216)	63	8	12570
1973	1930 (322)	6124 (680)	285		4228 (282)	70	0	12637
1974	4119 (515)	6391 (533)	200		1623 (325)	56	0	12388
1975	6186 (326)	5194 (577)	246		4408 (157)	26	0	16059
1976	4393 (1098)	5312 (885)	432	(216)	6117 (185)	46	33	16333
1977	6238 (1040)	4329 (481)	529		8246 (129)	117	134	19593
1978	9694	6817 (568)	906	(453)	7473 (156)	97	416	25404
1979	10555 (5278)	5133 (395)	515	(515)	8272 (251)	56	48	24580
1980	13471 (1225)	6926 (385)	1079	(360)	7046 (294)	82	0	28604
1981	14991 (333)	7861 (302)	967	(322)	6475 (809)	70	0	30364
1982	12120 (252)	7599 (345)	842	(70)	2972 (297)	32	0	23565
1983	12964 (231)	8548 (225)	751	(75)	2562 (197)	15	0	24840
1984	12097 (212)	6778 (226)	193	(193)	613 (77)	0	0	19682
1985	10292 (181)	4367 (182)	134		520 (104)	1	0	15314
1986	9630 (201)	5345 (184)	99		209 (209)	0	0	15282
1987	8103 (180)	4856 (270)	212	(19)	502 (84)	0	0	13673
1988	7174 (133)	3442 (156)	93	(93)	377 (189)	0	0	11085
1989	3731 (133)	2686 (244)	194		90 (22)	0	0	6701
1990	3322 (79)	3785 (135)	278	(278)	110	0	0	7495
1991	4171 (97)	5127 (151)	258	(258)	206 (69)	0	0	9761
1992	3462 (74)	6560 (177)	217	(109)	258 (86)	0	2	10500
1993	2620 (61)	4091 (136)	100	(14)	123 (31)	0	0	6935
1994	2068 (63)	2177 (84)	48		97 (48)	0	0	4391
1995	3035 (65)	2420 (81)	69		105 (105)	0	2	5631
1996	3593 (86)	2351 (59)	50	(50)	151 (151)	0	0	6145
1997	4214 (73)	2158 (94)	56	(56)	64 (13)	0	0	6493
1998	5154 (99)	2558 (80)	50		80 (40)	0	0	7842
1999*	1968 (46)	264 (264)	7		74 (11)	0	0	2313

1 = Includes Handline 2 = Gillnets (set, drift), traps, unspecified. * = 1999 Data only for quarters 1 and 2

Table 4a. Reported landings by month and gear type from NAFO Divisions 4X and 5Y. (from ZIF).

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mobile	85	331	2598	439	792	1067	1924	1306	856	1048	713	240	290	11602
	86	421	1806	754	364	1021	900	871	688	1852	938	206	242	10062
	87	448	1192	1739	520	1207	1142	549	293	1009	473	75	40	8687
	88	1312	1037	109	555	756	1185	670	117	1103	469	89	248	7648
	89	614	1082	667	289	193	735	171	83	47	15	9	24	3909
	90	720	794	77	244	379	361	315	113	154	95	100	87	3439
	91	280	508	122	159	449	589	440	195	280	235	319	811	4388
	92	578	414	225	97	353	659	450	137	197	161	163	293	3727
	93	259	232	223	107	396	467	320	166	209	163	147	67	2755
	94	112	244	137	155	227	195	234	141	202	160	121	252	2178
	95	246	375	518	117	182	185	207	188	269	292	188	402	3168
	96	197	450	481	270	203	141	267	275	364	414	453	319	3836
	97	78	457	539	399	176	249	337	277	558	502	420	311	4303
	98	319	885	1033	511	99	169	320	304	492	259	340	504	5234
	99	476	494	229	240	299	304							2043
Gillnet	85	0	0	2	1	1	2	16	43	36	10	0	1	113
	86	0	1	0	0	1	7	18	16	15	25	3	2	88
	87	2	1	4	7	15	17	32	24	44	58	12	0	215
	88	1	1	3	1	1	11	14	14	18	13	4	1	82
	89	0	0	0	12	2	13	10	15	41	35	25	4	158
	90	6	5	6	0	13	51	66	31	72	23	4	0	278
	91	0	0	2	5	5	20	18	63	98	41	2	1	257
	92	4	1	0	5	5	10	26	29	69	64	3	0	215
	93	0	0	1	2	4	18	11	14	36	12	1	0	100
	94	0	0	0	1	1	5	10	7	13	9	1	0	48
	95	0	0	0	1	0	6	10	2	49	1	0	0	69
	96	0	0	0	0	1	4	12	9	22	2	0	0	50
	97	0	0	0	0	0	4	8	23	14	6	0	1	57
	98	0	0	0	0	0	0	10	16	7	9	6	1	50
	99	0	0	0	0	0	6							7
Longline	85	457	1300	185	207	91	99	159	291	448	357	190	271	4056
	86	438	1107	316	117	84	102	186	429	713	821	418	356	4888
	87	718	1126	342	66	138	180	291	367	361	516	259	210	4575
	88	807	485	104	81	50	83	177	367	538	288	128	254	3362
	89	382	385	168	69	47	115	229	357	325	266	110	54	2506
	90	645	463	205	48	33	107	285	382	555	270	202	216	3391
	91	777	851	193	77	87	236	444	481	524	427	282	229	4589
	92	937	638	140	127	243	330	506	570	717	507	349	529	5592
	93	102	691	227	205	275	223	294	608	471	84	45	2	3228
	94	292	36	2	53	41	236	352	158	180	116	96	16	1580
	95	293	11	0	112	126	182	363	372	230	197	68	238	2173
	96	199	13	0	12	64	260	267	249	215	280	254	240	2053
	97	31	157	33	40	16	101	253	340	317	354	176	232	2049
	98	99	54	71	139	32	151	348	304	494	369	158	201	2421
	99	55	32	23	27	25	95							257
Handline	85	1	0	0	0	4	35	118	101	54	15	5	0	334
	86	0	0	0	0	3	50	188	120	72	29	7	0	469
	87	0	0	0	0	3	41	88	94	44	10	2	3	286
	88	0	0	0	0	0	10	15	32	38	21	9	1	126
	89	0	0	0	1	3	43	75	48	31	15	4	1	221
	90	0	0	0	0	3	77	93	114	82	20	4	2	396
	91	1	1	0	1	2	97	184	138	77	39	1	0	539
	92	0	0	0	0	5	132	315	290	143	70	14	4	974
	93	0	0	0	2	2	189	284	297	81	9	2	0	865
	94	0	0	0	0	9	256	242	61	26	5	1	0	600
	95	0	0	0	0	7	91	117	9	23	3	0	0	250
	96	0	0	0	0	4	134	113	44	0	2	0	0	298
	97	0	0	0	0	1	40	43	20	3	3	0	0	109
	98	0	0	0	0	0	21	55	27	32	1	0	0	137
	99	0	0	0	0	1	6							7
Total	85	789	3898	626	1000	1164	2060	1599	1291	1585	1096	436	562	16105
	86	859	2913	1071	481	1109	1059	1282	1254	2652	1613	635	599	15507
	87	1168	2320	2085	594	1363	1381	961	777	1458	1057	347	253	13763
	88	2119	1523	216	637	808	1289	876	529	1697	790	231	503	11217
	89	996	1447	836	371	245	906	485	504	444	330	147	83	6794
	90	1371	1262	288	293	429	597	739	640	864	408	309	305	7504
	91	1057	1361	318	241	542	942	1086	677	978	742	585	1042	9772
	92	1519	1052	366	228	606	1131	1297	1027	1127	801	529	825	10508
	93	361	924	452	316	676	897	909	1085	797	267	195	69	6947
	94	404	280	139	209	278	692	838	366	421	289	220	268	4405
	95	539	387	518	230	314	445	697	570	572	492	256	640	5660
	96	396	463	481	282	273	539	659	578	602	699	707	559	6237
	97	109	614	572	439	193	394	641	680	893	885	596	543	6519
	98	419	939	1103	650	132	352	739	643	1027	635	499	705	7842
	99	531	526	252	268	324	412							2313

Table 4b. Reported landings by unit area and gear type from NAFO Divisions 4X and 5Y. (from ZIF)

		4XL	4XM	4XN	4XO	4XP	4XQ	4XR	4XS	4XU	5Y	Total
Mobile	1985	0	144	1455	1949	1401	1930	1330	277	2326	791	11602
	1986	1	295	1624	1329	538	2254	910	198	2690	224	10062
	1987	0	132	2194	1059	901	1221	210	63	2823	83	8687
	1988	0	269	1007	728	963	559	107	22	3896	97	7648
	1989	0	41	733	454	1047	566	207	12	761	89	3909
	1990	0	35	468	533	738	886	223	5	543	7	3439
	1991	0	16	786	851	645	1153	739	87	93	11	4382
	1992	0	32	939	735	427	912	604	51	21	6	3727
	1993	0	7	503	500	355	925	296	108	50	12	2755
	1994	0	3	187	445	104	999	311	112	2	14	2178
	1995	0	7	222	275	1018	975	477	157	8	28	3168
	1996	0	10	541	214	758	995	800	413	14	92	3836
	1997	1	11	407	173	1063	860	1121	627	14	25	4303
	1998	0	25	1954	108	867	803	1013	404	4	56	5234
	1999	0	1	733	62	565	461	163	51	3	4	2043
Gillnet	1985	0	29	0	67	0	0	1	12	4	0	113
	1986	0	31	0	47	0	0	1	7	1	1	88
	1987	0	95	0	90	2	0	1	18	3	6	215
	1988	0	40	2	26	3	0	2	1	8	0	81
	1989	0	96	0	47	0	2	0	2	10	0	158
	1990	0	82	1	74	3	75	31	1	11	0	278
	1991	0	79	2	144	5	12	2	3	10	0	257
	1992	0	79	5	42	1	53	3	7	23	1	215
	1993	0	21	3	46	6	8	3	1	12	1	100
	1994	0	4	0	21	3	4	3	0	11	1	48
	1995	0	5	4	20	7	11	3	3	16	0	69
	1996	0	10	1	17	6	4	1	7	3	0	50
	1997	0	5	0	12	29	4	1	2	4	1	57
	1998	0	7	1	6	22	8	2	2	2	1	51
	1999	0	0	0	0	5	1	0	0	0	0	6
Longline	1985	0	493	485	1545	528	33	88	6	858	0	4036
	1986	0	856	432	1924	486	11	61	6	1100	0	4875
	1987	10	552	286	1798	391	54	33	2	1445	2	4572
	1988	0	359	403	791	247	30	18	21	1446	35	3350
	1989	0	256	219	861	277	28	9	1	814	4	2469
	1990	0	275	229	1309	368	30	3	8	1168	1	3391
	1991	0	409	561	1809	801	97	45	1	863	0	4586
	1992	0	133	458	2276	319	96	181	2	2119	1	5587
	1993	0	113	1129	994	400	178	202	1	211	0	3227
	1994	0	50	175	663	171	10	39	0	470	0	1578
	1995	0	82	672	616	435	149	13	3	200	0	2171
	1996	0	68	556	678	351	84	66	6	243	0	2053
	1997	0	73	616	490	380	61	30	8	391	0	2049
	1998	7	109	583	652	805	124	20	6	112	3	2421
	1999	0	13	122	41	54	20	3	0	4	0	257
Handline	1985	0	23	0	294	0	11	6	0	0	0	334
	1986	0	17	0	426	0	15	10	1	0	0	469
	1987	0	33	0	236	4	8	4	1	0	0	286
	1988	0	5	0	111	0	2	4	2	3	0	126
	1989	0	4	0	193	0	4	12	0	8	0	221
	1990	0	3	0	376	0	8	3	0	6	0	396
	1991	0	11	0	460	0	30	29	0	9	0	539
	1992	0	13	0	844	1	40	74	0	2	0	974
	1993	0	3	7	775	27	14	32	3	3	0	865
	1994	0	1	2	488	21	75	11	0	4	0	800
	1995	0	0	2	140	13	3	0	0	91	0	250
	1996	0	2	5	248	13	14	3	1	13	0	298
	1997	0	1	1	72	5	6	2	0	23	0	109
	1998	0	1	1	111	2	8	0	0	14	0	137
	1999	0	0	7	3	1	1	1	0	1	0	14
Total	1985	0	699	1941	3861	1928	1974	1426	295	3191	791	16105
	1986	1	1203	2055	3732	1023	2280	982	212	3794	225	15507
	1987	10	814	2481	3183	1297	1283	249	84	4271	90	13763
	1988	0	673	1412	1656	1212	597	131	46	5358	132	11217
	1989	0	432	952	1557	1324	599	228	15	1593	92	6794
	1990	0	396	698	2292	1106	999	259	14	1729	9	7504
	1991	0	515	1349	3264	1452	1292	816	91	975	12	9766
	1992	0	259	1402	3898	749	1104	852	60	2166	8	10508
	1993	0	144	1642	2316	788	1124	533	112	276	13	6947
	1994	0	58	365	1618	296	1088	364	113	487	15	4405
	1995	0	95	900	1052	1473	1139	493	164	316	28	5660
	1996	0	89	1103	1158	1127	1097	870	427	274	92	6237
	1997	1	90	1025	746	1477	931	1154	638	431	25	6518
	1998	7	142	2539	877	1696	943	1035	412	132	60	7843
	1999	0	14	862	106	625	483	167	51	8	4	2320

Table 5. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding unit area 5Y) by gear type, tonnage class, area and quarter, 1985 - 1999. Only first 2 quarters included for 1999.

		OTB				LL		MISC		
		mnop		qr		mnop	qr	Mnop	qr	
		1-3	4+	1-3	4+	1-3	1-3	1-3	1-3	Total
1985	1	2702	522	138	0	1926	11	12	0	
	2	2391	21	1226	0	345	46	105	29	
	3	230	17	2212	13	822	59	455	52	
	4	89	17	738	0	815	3	41	4	15041
1986	1	2568	147	157	0	1964	5	0	0	
	2	830	20	1317	0	329	32	0	0	
	3	794	14	2284	1	1719	62	0	0	
	4	642	27	609	0	1451	13	0	0	14985
1987	1	3026	219	108	0	2161	26	31	0	
	2	1965	163	667	5	366	58	40	1	
	3	442	42	1271	3	1201	42	85	0	
	4	89	69	384	0	995	5	74	0	13538
1988	1	2203	77	81	0	1368	19	25	0	
	2	1476	222	763	16	176	29	22	5	
	3	1126	17	688	4	1075	29	45	2	
	4	612	40	125	0	650	7	19	0	10921
1989	1	2121	34	143	0	916	9	36	0	
	2	501	8	587	3	216	59	55	1	
	3	46	2	253	0	1023	36	65	1	
	4	2	42	3	0	440	0	64	0	6666
1990	1	1341	42	93	1	1267	8	20	0	
	2	229	16	723	0	256	11	9	56	
	3	125	16	427	1	1447	29	115	53	
	4	128	25	117	1	707	6	27	1	7297
1991	1	792	37	71	4	1800	20	10	0	
	2	305	64	766	3	451	46	27	5	
	3	200	20	627	4	1702	140	168	17	
	4	865	34	435	17	929	29	48	0	9636
1992	1	1006	92	76	0	1698	17	43	0	
	2	410	116	563	0	707	105	22	3	
	3	197	8	534	7	2240	256	66	51	
	4	264	8	315	14	1368	77	55	11	10329
1993	1	598	49	62	2	1009	13	0	0	
	2	388	49	503	4	671	220	18	5	
	3	155	3	436	11	1822	209	54	6	
	4	130	5	236	0	138	2	12	1	6811
1994	1	239	19	231	2	331	0	0	0	
	2	194	7	362	1	535	61	5	3	
	3	87	2	399	0	923	90	23	7	
	4	144	48	300	16	233	2	8	0	4272
1995	1	798	74	258	1	301	0	0	0	
	2	109	2	357	7	369	125	3	4	
	3	70	4	446	0	1054	38	43	13	
	4	456	9	383	1	447	29	0	1	5402
1996	1	696	111	317	1	203	9	0	0	
	2	233	4	352	1	405	63	4	1	
	3	111	3	423	5	788	85	31	5	
	4	352	16	697	3	734	27	1	1	5682
1997	1	716	19	332	1	220	1	0	0	
	2	363	2	379	1	160	37	4	1	
	3	220	1	644	4	915	54	38	4	
	4	324	16	614	13	723	30	6	0	5842
1998	1	1957	27	250	0	221	3	0	0	
	2	562	4	210	1	306	38	9	1	
	3	81	2	1005	3	1166	95	21	9	
	4	284	39	749	3	694	32	6	2	7819
1999	1	992	69	138	1	109	0	0	0	
	2	300	1	534	4	129	25	5	2	
	3									
	4									2309

Table 6.

1998 4X Haddock Quota and Catch from Atlantic Quota Monitoring Report

	Quota	Catch
FG<45	2370	2235
FG45-64	341	332
FG65-100 bycatch	45	51
MG<65 (ITQ)	4734	4728
MG<65 (Gen)	142	144
MG65-100 bycatch	45	33
Vessels > 100	423	365
Total	8100	7800

1999 4X Haddock Quota and Catch from Atlantic Quota Monitoring Report (to Oct. 22/99)

	Quota	Catch	%
FG<45	2868	1407	49
FG45-64	413	152	37
FG65-100 bycatch	54	44	81
MG<65 (ITQ)	5681	3462	61
MG<65 (Gen)	218	141	65
MG65-100 bycatch	54	42	78
Vessels > 100	512	205	40
Total	9800	5453	56

Table 7. Summary of commercial sampling for the 4X haddock fishery in 1998. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop		4Xqr	
	TC1-3	TC4+	TC1-3	TC4+
1	1957.26 (425 - 3797)	26.56 (0 - 0)	250.02 (134 - 930)	0.47 (0 - 0)
2	561.93 (129 - 1250)	3.69 (26 - 211)	209.96 (127 - 1538)	1.43 (0 - 0)
3	80.66 (57 - 505)	1.94 (0 - 0)	1005.93 (111 - 864)	2.79 (0 - 0)
4	284.27 (87 - 1112)	39.10 (0 - 0)	749.24 (146 - 1627)	3.22 (24 - 210)

Longline/Handline*

Quarter	4Xmnop		4Xqr	
	TC1-3	TC4+	TC1-3	TC4+
1	220.64 (27 - 455)	0 (0 - 0)	2.97 (0 - 0)	0 (0 - 0)
2	306.12 (62 - 1026)	0 (0 - 0)	37.53 (65 - 716)	0 (0 - 0)
3	1166.18 (74 - 1447)	0 (0 - 0)	95.49 (35 - 451)	0 (0 - 0)
4	693.57 (110 - 1448)	0 (0 - 0)	32.02 (0 - 225)	0 (0 - 0)

Miscellaneous*

Quarter	4Xmnop		4Xqr	
	TC1-3	TC4+	TC1-3	TC4+
1	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
2	9.24 (0 - 0)	0 (0 - 0)	1.27 (0 - 0)	0 (0 - 0)
3	21.39 (0 - 0)	0 (0 - 0)	9.23 (0 - 0)	0 (0 - 0)
4	6.32 (0 - 0)	0 (0 - 0)	1.53 (0 - 0)	0 (0 - 0)

* - Longline Length Age-Length Keys applied to Miscellaneous Landings

Table 8. Summary of commercial sampling for the 4X haddock fishery in 1999. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop		4Xqr	
	TC1-3	TC4+	TC1-3	TC4+
1	991.73 (476-4624)	68.59 (125-1124)	138.43 (115 - 848)	0.53 (0 - 0)
2	299.85 (160-1300)	1.36 (0 - 0)	534.298 (236-1678)	3.68 (28 - 220)
3	(-)	(-)	(-)	(-)
4	(-)	(-)	(-)	(-)

Longline/Handline*

Quarter	4Xmnop		4Xqr	
	TC1-3	TC4+	TC1-3	TC4+
1	109.39 (0 - 220)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
2	128.80 (0 - 0)	0 (0 - 0)	25.56 (-)	0 (0 - 0)
3	(-)	(-)	(-)	(-)
4	(-)	(-)	(-)	(-)

Miscellaneous*

Quarter	4Xmnop		4Xqr	
	TC1-3	TC4+	TC1-3	TC4+
1	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
2	5.11 (0 - 0)	0 (0 - 0)	1.61 (0 - 0)	0 (0 - 0)
3	(-)	(-)	(-)	(-)
4	(-)	(-)	(-)	(-)

* - Otter Trawl Age-Length Keys applied to Longline, Handline, and Miscellaneous landings.

Table 9. 4X haddock commercial catch-at-age (000's). (1999 for quarters 1 and 2 only)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0	0	42	152	1	37	18	2	0	0	16	1	0	0	2
2	1088	809	22	3114	713	2198	1306	1289	77	83	164	1210	526	70	763
3	747	1660	3490	114	4783	4617	1657	3137	3453	1184	2497	2268	3895	3621	1195
4	1549	809	1871	2274	318	5220	4295	2026	7221	6862	3071	6369	2648	6020	5046
5	391	1460	517	1080	1829	490	3712	3204	2156	3970	5527	4300	4954	4104	3708
6	541	415	656	533	523	1115	437	2891	2916	1094	3573	3272	1823	2454	2583
7	4679	71	91	607	194	250	813	361	1071	1272	538	1191	1560	1033	1022
8	1922	3404	58	326	277	174	155	390	141	269	636	366	364	434	367
9	137	1047	1185	282	191	63	72	107	110	58	173	331	196	206	119
10	99	167	520	621	277	32	96	72	27	70	35	99	101	131	83
11	181	186	26	56	567	167	39	23	9	11	21	14	48	76	39
12	28	150	196	13	25	231	104	8	6	1	3	24	17	27	22
13	38	108	93	6	4	11	158	87	49	18	10	9	15	27	13
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0	0	0	13	13	0	3	8	22	10	3	0	0	0	0
2	228	294	90	214	190	403	52	141	139	98	99	37	13	31	4
3	2105	1153	1043	512	497	1422	1304	243	709	368	757	809	526	149	84
4	2455	4871	3030	1016	499	394	2351	2523	520	632	694	993	1676	1052	91
5	4658	4021	4588	896	936	358	580	2290	1828	327	617	682	1008	1795	504
6	1508	1512	2096	1968	310	472	246	229	1070	971	238	428	455	1137	513
7	509	226	291	871	720	391	310	247	170	269	449	355	269	536	308
8	136	98	58	894	460	654	200	331	106	24	421	439	138	329	124
9	51	36	7	372	504	277	310	237	73	17	162	355	110	181	45
10	16	31	9	209	255	204	280	240	46	13	24	130	94	192	30
11	7	11	6	146	57	61	142	132	58	20	26	17	35	140	26
12	4	6	0	49	81	48	169	152	51	15	18	1	4	31	13
13	2	3	0	44	30	9	71	36	12	7	11	3	2	6	4
14	4	4	0	22	12	9	13	15	7	1	11	1	0	8	0
15	0	0	0	7	4	2	4	2	1	0	3	1	0	5	0
16	0	0	0	4	0	1	4	2	0	1	2	2	1	1	0

Table 10. 4X haddock catch numbers-at-age from projection in last year's assessment and the actual catch-at-age.

1998 catch numbers-at-age

Predicted			Actual		
Age	# (000s)	%	Age	# (000s)	%
1	0	0	1	0	0
2	71	1	2	31	1
3	217	4	3	149	3
4	1717	32	4	1052	19
5	1988	37	5	1795	32
6	655	12	6	1137	20
7	227	4	7	536	10
8	242	5	8	329	6
9	108	2	9	181	3
10	134	2	10	192	3
			11	140	3
			12	31	1
			13	6	0
			14	8	0
			15	5	0
			16	1	0
1+	5360	100	1+	5594	100

1999 catch numbers-at-age

Predicted			Actual		
Age	# (000s)	%	Age	# (000s)	%
1	0	0	1	0	0
2	73	1	2	4	0
3	212	4	3	84	5
4	655	12	4	91	5
5	2400	43	5	504	29
6	1466	26	6	513	29
7	446	8	7	308	18
8	150	3	8	124	7
9	159	3	9	45	3
10	71	1	10	30	2
			11	26	1
			12	13	1
			13	4	0
			14	0	0
			15	0	0
			16	0	0
1+	5632	100	1+	1746	100

Note: 1999 actual catch January – June only.

Table 11. 4X Haddock commercial weight-at-age (kg). (1999 for quarters 1 and 2 only)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.290	0.290	0.290	0.270	0.180	0.230	0.230	0.280	0.290	0.290	0.160	0.230			0.250
2	0.570	0.500	0.450	0.510	0.460	0.520	0.520	0.460	0.440	0.510	0.522	0.593	0.493	0.394	0.527
3	0.900	0.960	0.900	0.750	0.820	0.820	0.810	0.710	0.870	0.870	0.882	0.877	0.907	0.758	0.785
4	1.050	1.250	1.350	1.250	1.100	1.200	1.190	1.220	1.330	1.330	1.326	1.260	1.294	1.141	1.069
5	1.160	1.400	1.600	1.800	1.700	1.550	1.600	1.720	1.850	1.840	1.777	1.721	1.653	1.714	1.411
6	1.430	1.500	1.750	2.000	2.300	2.250	2.100	2.200	2.330	2.360	2.355	2.219	2.130	2.146	1.932
7	1.650	1.750	1.900	2.200	2.500	2.850	2.950	2.940	2.700	2.830	2.906	2.654	2.577	2.607	2.287
8	1.950	1.950	2.100	2.300	2.600	3.000	3.500	3.300	3.390	3.300	3.278	3.134	2.947	2.869	2.683
9	2.300	2.300	2.300	2.500	2.800	3.200	3.600	3.570	3.770	4.030	3.811	3.608	3.470	3.108	3.054
10	2.820	2.650	2.800	2.700	2.950	3.450	3.800	3.770	4.170	4.150	4.332	3.688	4.033	3.550	3.431
11	2.800	3.250	3.000	3.300	3.200	3.500	4.100	3.690	4.030	4.960	4.200	4.546	3.946	3.630	3.841
12	2.850	3.000	3.700	3.400	3.800	3.700	4.000	3.940	3.620	6.000	4.963	4.823	4.033	3.780	4.114
13	3.600	3.000	3.300	4.200	3.900	4.400	4.200	3.910	4.630	5.680	5.711	4.680	4.908	4.064	4.000
14															
15															
16															

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1988-97
1				0.439			0.550	0.671			0.161					0.455
2	0.573	0.522	0.615	0.848	0.810	0.666	1.159	0.790	0.796	0.872	0.773	0.906	0.827	0.611	0.482	0.845
3	0.830	0.728	0.779	1.085	1.085	1.073	1.104	1.026	0.972	1.139	1.074	1.011	1.030	0.922	0.853	1.060
4	1.071	1.022	1.005	1.179	1.232	1.431	1.440	1.232	1.129	1.312	1.369	1.217	1.289	1.029	1.037	1.283
5	1.408	1.380	1.328	1.469	1.350	1.809	1.833	1.572	1.392	1.483	1.597	1.396	1.561	1.230	1.170	1.546
6	1.966	1.838	1.796	1.522	1.511	1.740	2.016	1.956	1.734	1.793	1.730	1.598	1.869	1.429	1.546	1.747
7	2.442	2.506	2.472	1.683	1.690	2.001	2.088	1.887	2.132	2.080	1.976	1.614	2.048	1.676	1.465	1.920
8	2.920	2.775	3.123	1.794	1.672	2.050	2.234	1.963	2.098	2.493	2.013	1.860	2.069	1.880	1.660	2.025
9	3.501	3.396	4.061	2.031	1.815	2.108	2.240	2.158	2.365	2.101	2.355	2.136	2.199	2.080	1.822	2.151
10	3.313	3.493	3.309	2.256	1.882	2.351	2.228	2.167	2.242	2.775	2.286	2.042	2.357	2.122	1.778	2.259
11	4.029	3.299	4.150	2.373	2.256	2.316	2.274	2.100	2.377	2.204	2.584	2.750	2.648	2.433	1.865	2.388
12	4.424	3.331	4.775	2.570	2.379	2.613	2.339	1.968	2.148	2.381	2.305	3.373	2.550	2.939	1.585	2.463
13	5.468	4.286	5.173	2.329	2.490	2.373	2.327	2.660	2.521	2.899	2.623	3.027	3.072	3.537	1.934	2.632
14	5.595	4.804	5.827	3.302	2.713	3.126	2.654	2.919	2.887	4.510	2.902	3.271	4.481	3.604		3.277
15				3.767	3.135	3.204	3.421	3.218	4.777	4.308	3.095	3.490		2.348	5.184	3.602
16			7.526	4.754	6.052	4.546	3.787	5.541	5.628	2.486	3.224	3.286	3.674	3.081		4.298

Table 12. 4X haddock mean numbers per standard tow by stratum from the 1970-99 summer RV survey.

	trawlable units	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
470	77962	3.94	0.58	5.68	5.13	0.41	4.20	0.70	273.93	5.75	38.25	3.28	6.09	0.00	36.34	12.58
471	85080	0.00	0.00	2.47	0.00	0.00	0.55	0.00	0.44	0.46	0.55	2.92	2.86	4.89	3.89	0.46
472	105842	13.72	37.80	15.86	12.56	28.86	49.18	35.25	14.92	10.53	32.55	248.91	192.03	141.20	39.75	49.03
473	22456	89.87	9.98	82.22	51.92	53.90	11.50	113.46	170.97	26.39	81.28	31.42	10.60	135.88	34.22	60.70
474	13643	55.73	25.61	28.96	39.50	75.43	97.01	76.85	26.00	103.58	303.43	27.18	119.46	135.37	58.27	0.00
475	13220	78.14	53.88	21.97	57.63	105.68	27.13	137.04	36.58	81.00	77.82	71.20	46.08	48.50	53.94	254.51
476	125248	0.00	84.58	12.38	0.00	41.53	39.53	1.31	1055.25	53.78	0.00	23.10	14.84	5.50	62.34	8.75
477	104401	45.40	34.13	24.52	31.91	132.00	25.24	66.94	31.07	45.54	44.47	35.92	53.20	94.15	86.99	150.81
478	19745	1.75	1.75	0.70	0.58	2.52	3.21	10.50	4.68	6.15	2.52	1.75	0.67	2.94	17.14	16.73
480	55506	100.65	242.10	98.74	132.80	264.49	179.52	64.13	631.56	192.55	88.73	224.06	180.81	73.74	93.29	172.05
481	158890	63.26	30.89	31.69	183.36	273.08	49.72	56.51	30.81	72.98	85.20	169.64	35.11	170.30	41.82	70.77
482	88301	2.33	3.32	0.00	0.00	5.83	3.06	4.69	9.75	8.40	20.54	14.75	9.92	23.33	8.58	20.90
483	45082	2.53	0.00	4.08	0.00	1.85	2.10	30.33	9.96	1.75	11.05	23.50	32.23	70.04	5.66	33.42
484	191855	0.00	0.53	0.00	0.37	0.35	0.39	6.11	0.41	0.58	14.87	2.33	1.67	6.04	1.28	4.12
485	134061	52.16	11.78	3.11	31.92	9.29	12.00	14.77	34.48	13.88	10.87	65.92	15.01	24.85	11.29	26.44
490	50930	30.43	56.87	0.53	70.77	324.45	48.12	109.15	189.51	63.48	384.72	311.15	1479.70	485.53	234.97	773.65
491	58217	4.16	0.00	11.39	3.92	21.05	3.01	2.58	21.30	11.52	5.21	15.37	15.48	30.46	32.01	29.26
492	92029	1.22	21.00	6.74	4.81	19.83	7.78	25.55	16.21	7.68	28.29	5.64	21.31	103.64	18.56	1.24
493	45167	2.42	0.95	1.56	4.37	0.74	6.15	4.42	6.56	10.57	0.41	1.58	3.09	1.65	0.39	36.04
494	35337	0.00	1.40	5.75	7.45	16.16	6.03	3.49	16.57	4.86	17.29	1.85	3.21	5.04	0.00	5.56
495	49489	16.80	13.56	9.33	4.00	20.19	1.73	4.87	33.92	48.00	31.46	6.75	8.68	38.59	14.84	3.09

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
470	0.97	41.18	6.61	6.46	3.19	1.54	0.00	0.97	0.49	0.00	2.11	5.68	16.49	8.09	0.97	16.92
471	0.00	0.51	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	1.01	0.00	1.01	5.34	0.87
472	73.40	73.09	28.21	34.73	47.23	17.47	19.11	7.89	7.32	14.77	42.50	74.95	30.98	7.25	194.46	48.31
473	189.10	174.07	80.29	12.01	12.32	41.51	92.36	5.83	0.46	47.42	210.78	352.79	101.04	199.85	85.43	85.66
474	134.50	52.61	3.15	1.54	1.80	31.11	6.32	6.69	8.26	8.16	8.15	41.32	107.22	92.83	58.35	57.79
475	100.85	159.04	14.13	13.90	22.10	54.47	22.48	16.04	8.75	125.37	164.81	175.06	46.38	47.18	65.12	73.16
476	369.87	22.39	25.03	9.10	9.21	5.30	8.51	11.67	2.83	14.82	51.60	52.17	72.14	25.26	19.05	71.82
477	92.13	120.41	43.99	59.48	42.02	24.37	38.58	39.23	12.84	56.47	248.00	86.51	60.13	120.74	213.79	67.14
478	20.42	9.48	25.39	11.32	0.00	13.83	0.00	4.88	3.40	14.39	5.30	22.14	5.90	3.09	6.14	7.35
480	117.45	97.60	52.78	84.96	175.59	251.54	316.69	200.96	71.76	173.09	274.90	226.30	341.80	322.51	1022.21	187.83
481	18.68	168.47	31.93	25.72	29.26	18.03	40.43	25.32	41.43	41.01	145.58	102.30	71.88	58.67	274.05	75.30
482	1.46	2.06	31.63	22.73	18.19	39.56	20.86	1.50	7.29	19.23	18.65	138.92	25.17	10.82	19.44	17.02
483	14.58	13.00	11.48	20.59	1.54	36.84	41.78	4.03	3.83	0.50	3.54	1.96	17.23	4.46	4.22	13.93
484	2.94	0.69	0.00	1.37	0.97	0.97	0.00	0.00	0.70	0.65	3.03	5.17	2.91	3.01	3.73	2.12
485	80.44	35.57	2.97	9.68	1.86	13.13	87.06	20.51	8.40	1.69	78.02	94.92	4.35	34.48	84.82	27.96
490	160.56	31.56	44.66	128.41	129.52	174.02	79.27	104.55	18.53	412.74	541.72	336.00	267.88	139.75	62.71	245.94
491	16.34	3.09	1.03	0.26	0.00	0.67	1.30	3.56	4.80	22.25	63.99	9.09	44.53	10.16	38.49	13.37
492	5.04	1.97	2.63	5.33	0.31	0.00	0.39	8.21	0.00	7.00	6.02	4.69	37.18	67.20	7.05	15.02
493	2.31	35.48	13.65	0.00	0.00	0.00	0.00	1.56	0.00	0.00	1.12	0.62	24.29	1.63	5.90	5.57
494	3.50	26.49	0.00	0.70	0.00	0.00	2.92	0.58	0.00	6.00	25.43	300.70	0.00	17.83	29.51	16.51
495	5.22	0.00	0.00	0.98	0.00	18.05	0.00	0.00	0.00	4.93	55.27	16.99	48.84	21.23	61.06	14.74

Table 13. 4X haddock mean numbers-at-age per standard tow from the 1970-99 summer RV survey strata 470-495.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.47	0.03	0.54	0.14	0.32	0.27
1	5.21	0.10	4.72	5.79	10.31	6.02	4.98	5.77	5.54	1.84	19.84	32.96	11.70	6.11	3.75
2	4.17	10.08	0.21	20.57	20.72	3.24	5.86	36.36	4.73	12.40	6.32	25.43	25.10	4.04	21.44
3	1.23	4.38	3.04	0.66	29.86	4.83	3.77	56.66	10.95	7.46	13.92	6.15	11.91	12.89	10.99
4	2.31	1.94	1.38	2.89	0.91	7.17	3.94	16.13	3.74	9.45	7.16	8.43	4.73	5.70	16.56
5	0.93	2.70	0.81	1.36	3.74	0.37	6.65	15.62	1.55	4.78	11.12	3.43	7.69	3.36	5.20
6	2.14	1.28	0.90	0.48	0.84	1.62	0.58	8.31	2.98	2.00	4.29	3.80	3.14	2.12	2.66
7	5.51	1.99	0.59	0.70	0.49	0.41	0.72	1.17	1.18	2.99	1.55	1.21	3.43	0.87	1.28
8	0.78	5.49	0.92	0.52	0.59	0.31	0.13	1.41	0.08	1.29	1.17	0.16	0.59	0.31	0.54
9	0.31	0.71	1.44	0.34	0.32	0.13	0.07	0.16	0.00	0.22	0.59	0.30	0.38	0.29	0.36
10	0.30	0.08	0.05	0.57	0.23	0.11	0.02	0.14	0.00	0.10	0.23	0.18	0.21	0.21	0.08
11	0.07	0.04	0.01	0.02	0.35	0.34	0.01	0.02	0.04	0.00	0.03	0.08	0.14	0.17	0.03
12	0.02	0.10	0.00	0.00	0.00	0.26	0.14	0.15	0.03	0.00	0.00	0.04	0.00	0.05	0.03
13	0.00	0.00	0.01	0.01	0.00	0.00	0.10	0.08	0.02	0.00	0.00	0.00	0.00	0.05	0.04
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.09	0.06	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.18	0.03	0.06	0.05	0.11	0.05	0.03
4X total	22.98	28.89	14.09	33.91	68.35	24.80	27.12	142.58	31.16	43.21	66.31	82.76	69.27	36.54	63.25
SS total	33.23	48.43	24.94	56.32	107.91	42.24	37.20	259.92	49.33	46.92	95.79	59.54	80.09	49.49	62.54
BoF total	12.85	9.57	3.35	11.75	29.21	7.55	17.15	26.51	13.19	39.55	37.16	105.72	58.56	23.74	63.95

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
0	0.00	0.14	0.00	0.06	0.00	0.17	0.00	0.00	0.00	2.55	0.18	2.00	0.12	1.63	24.78	0.30
1	6.31	3.44	1.20	6.44	5.39	0.07	3.86	2.81	4.17	19.09	41.81	4.53	9.02	8.98	38.11	8.34
2	6.68	8.54	1.38	1.92	8.79	9.56	1.24	2.24	0.95	5.34	22.41	24.17	5.30	6.94	16.62	10.62
3	20.81	6.75	2.45	0.91	1.76	8.60	11.36	0.88	1.57	1.98	10.63	22.71	19.25	4.26	9.75	10.09
4	9.54	13.55	3.03	1.90	0.82	1.58	10.37	6.92	0.60	1.78	3.77	11.56	11.62	12.52	4.98	6.28
5	13.15	5.30	3.67	2.65	1.66	1.28	2.18	4.92	1.72	0.36	1.71	4.67	3.60	6.74	8.54	4.24
6	3.38	5.66	2.57	2.81	0.71	1.42	1.20	0.94	1.04	1.75	0.70	1.54	1.50	1.72	4.93	2.22
7	1.68	2.02	1.85	1.34	1.47	1.29	1.08	0.35	0.17	1.02	1.43	1.07	0.55	1.39	2.45	1.41
8	1.06	1.04	0.81	1.05	0.52	1.08	0.90	0.36	0.13	0.14	0.37	1.50	0.17	0.91	1.04	0.84
9	0.59	0.59	0.23	0.85	0.44	0.45	0.67	0.26	0.05	0.05	0.09	0.37	0.28	0.25	0.90	0.37
10	0.22	0.34	0.29	0.36	0.13	0.37	0.79	0.19	0.04	0.08	0.00	0.30	0.18	0.16	0.23	0.21
11	0.06	0.06	0.06	0.12	0.10	0.18	0.08	0.04	0.09	0.01	0.00	0.12	0.02	0.11	0.23	0.08
12	0.03	0.10	0.01	0.01	0.08	0.08	0.08	0.02	0.02	0.05	0.02	0.02	0.01	0.01	0.15	0.05
13	0.03	0.06	0.00	0.00	0.00	0.05	0.02	0.00	0.03	0.09	0.00	0.07	0.00	0.00	0.07	0.02
14	0.04	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unknown	0.03	0.10	0.70	0.48	0.05	0.02	0.00	0.08	0.02	0.00	0.02	0.27	0.04	0.01	0.00	0.09
4X total	65.60	47.69	18.28	20.70	21.93	26.23	33.83	20.02	10.61	34.28	83.15	74.90	51.69	45.64	110.79	45.17
SS total	103.66	83.46	28.12	26.89	32.94	31.14	42.94	28.36	17.11	36.53	105.62	81.95	69.99	65.11	191.56	62.33
BoF total	27.94	12.30	8.55	14.58	11.05	21.37	24.82	11.76	4.17	32.06	60.92	67.92	33.59	26.38	30.88	28.18

Table 14. 4X Haddock summer RV survey Scotian Shelf strata 470-481 - mean length-at-age (cm).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0								8.5		7.3	6.5	8.3	6.5	7.7	8.2
1	21.0	20.6	20.0	21.3	20.8	21.9	20.5	21.7	19.0	19.5	19.8	16.9	17.7	17.6	17.8
2	33.8	29.2	26.9	29.9	30.9	31.5	31.1	34.7	33.0	29.6	31.7	29.7	24.1	25.5	24.5
3	41.0	40.7	39.0	34.9	38.8	40.6	38.3	42.2	41.8	36.4	39.0	40.8	36.0	34.3	32.0
4	45.0	46.4	48.2	48.4	44.3	47.8	47.9	47.6	48.6	47.2	47.9	46.9	45.7	44.6	40.2
5	49.7	51.1	52.6	53.4	53.8	54.2	51.6	53.4	53.6	52.3	53.4	53.3	50.5	52.1	47.4
6	52.4	52.8	55.7	58.8	58.2	58.2	57.4	55.8	57.3	58.2	57.1	57.5	55.7	55.3	54.2
7	56.4	54.7	56.1	59.2	61.3	63.6	61.6	63.0	60.7	60.7	61.4	60.1	59.0	60.2	57.1
8	60.5	57.6	59.7	60.6	62.4	64.7	60.5	64.9		62.1	62.9	64.7	63.0	61.1	59.4
9	62.2	62.9	62.2	61.8	63.1	65.6		69.9		69.2	66.4	66.1	68.1	63.0	61.8
10	67.3	69.5	64.4	63.8	62.2	69.7		64.5			67.5	68.0		63.2	
11	68.0	69.4	69.5	67.6	66.5	68.4			62.5		70.5	70.5	66.5	61.4	
12	60.5	72.0	76.5			67.1	64.5	67.0						73.8	
13							66.5	70.5						70.5	
14								66.4							
15										68.5					
16															
17															

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
0		6.5		6.5	10.5					9.1	8.5	9.8	8.3	9.6	9.9	8.1
1	19.1	19.4	19.3	18.5	20.3	21.5	20.5	18.9	22.1	22.3	18.2	17.8	20.8	18.6	21.4	19.8
2	28.7	29.8	29.6	31.9	30.8	30.6	34.5	30.1	31.6	32.9	30.3	26.3	27.7	26.0	25.5	30.0
3	33.7	36.3	36.7	38.9	40.3	39.8	40.3	39.4	39.6	39.3	39.2	36.4	32.7	33.8	35.3	38.0
4	40.6	38.7	40.9	42.0	41.9	44.7	46.5	45.1	45.9	45.4	45.8	42.7	39.7	36.9	37.5	44.6
5	44.5	44.6	43.6	45.8	47.1	49.7	49.9	48.9	49.3	48.1	49.4	45.7	45.3	42.1	40.5	49.5
6	48.7	47.5	47.0	45.9	50.2	50.4	55.0	54.4	53.6	49.5	50.9	50.6	46.6	46.2	43.7	53.1
7	53.9	50.3	50.3	48.0	49.6	50.1	54.7	56.0	54.6	51.9	53.2	52.4	50.4	49.2	44.9	55.8
8	56.2	54.2	51.7	50.2	50.5	51.9	54.5	53.2	54.4	55.5	56.3	52.8	54.2	53.4	47.9	57.6
9	57.1	57.9	54.2	51.3	51.6	54.4	52.3	52.5	51.0	53.3	60.3	56.1	54.0	52.0	47.8	59.3
10	60.9	58.4	56.2	51.3	54.7	49.5	49.9	62.4	58.0	54.5		49.9	54.0	54.5	51.1	59.8
11		64.8	58.5	59.2	55.5	58.0	63.3	58.5	53.6	58.5		58.5	60.3	57.8	54.2	62.9
12		67.0		62.5	50.9	54.0	58.4	62.5	56.5	51.5	54.5	59.6	62.5	54.5	55.1	61.9
13		60.5						68.5	56.4	52.0		52.5			51.4	62.2
14	66.5				66.5	66.5	68.5		74.5							68.1
15																68.5
16																
17							64.5									64.5

Table 15. 4X Haddock summer RV survey Bay of Fundy strata 482-495 - mean length-at-age (cm).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0										6.5				8.3	
1	22.0		16.5	24.5	22.0	22.2	23.3	23.6	19.6	21.3	22.8	21.6	22.1	22.6	24.1
2	34.8	32.9		31.5	32.4	36.7	33.9	38.4	37.8	34.6	34.6	33.3	31.7	33.2	31.7
3	41.5	44.6	44.3	39.8	42.5	46.2	43.3	46.8	46.7	44.3	42.9	41.6	41.1	42.2	36.5
4	47.1	49.8	51.2	52.6	49.3	51.1	49.8	52.7	53.0	52.6	51.3	50.1	50.3	49.9	46.3
5	50.0	53.2	54.8	57.8	59.8	54.5	55.7	57.9	56.8	59.1	57.2	59.3	56.0	57.1	52.3
6	51.5	54.3	57.6	61.8	63.9	65.7	62.5	61.0	59.3	62.7	62.9	63.3	61.7	61.7	57.6
7	56.0	55.8	59.6	61.6	61.1		68.2	67.4	62.7	65.1	63.4	66.2	65.4	64.4	61.7
8	58.9	60.9	61.8	60.9	65.6		66.5	67.2	66.2	67.8	63.8	62.5	68.5	66.5	63.4
9	58.7	63.2	64.2	65.2	62.8		65.7	69.7		72.4	68.0	69.3	68.8	66.7	66.8
10	62.7	74.5	72.9	63.9	66.6	64.5	66.5	65.6		69.1		74.9	74.6	70.4	69.4
11	68.5				69.6	65.7	72.5	66.5				72.5	75.9	73.2	70.5
12		73.4				66.7	67.7	76.5	68.5			74.5		66.5	72.5
13			78.5	70.5			71.7	73.2	72.5					76.5	66.5
14								74.1	73.1	72.5					
15									70.3	73.9					
16															
17															

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
0		6.5				8.5				8.1	7.3	8.1	8.5	8.5	8.9	7.8
1	24.0	23.7	25.2	24.9	21.8		23.9	22.4	21.7	25.0	20.0	21.1	23.0	21.0	23.4	22.5
2	36.1	36.7	37.9	37.2	35.5	36.9	43.6	35.0	38.2	36.3	34.9	30.3	30.8	33.5	32.6	35.0
3	42.8	45.3	46.4	47.1	41.2	46.2	47.1	34.5	45.6	47.2	45.2	42.1	39.1	40.4	43.8	43.3
4	47.2	50.3	51.9	51.0	49.7	53.6	53.3	53.0	51.9	54.5	51.4	51.4	46.5	45.7	47.8	50.6
5	52.7	52.2	54.2	55.0	52.6	55.6	54.7	58.7	55.9	70.5	57.7	56.4	53.6	50.2	49.2	55.9
6	61.9	57.1	62.3	57.0	55.9	58.6	61.5	58.7	59.4	62.5	59.9	58.0	58.5	55.8	51.3	59.8
7	63.9	58.1	61.4	63.9	57.5	59.9	62.5	62.8	61.9	64.4	61.9	60.3	59.4	56.9	54.5	61.9
8	64.7	56.5	58.5	59.6	53.9	63.9	64.0	61.1	60.5	67.6	62.8	61.5	71.8	59.6	60.3	63.1
9	63.7	64.4	65.7	66.8	62.5	65.0	65.6	67.5			70.5	64.5	71.8	60.8	60.9	66.0
10	67.1	63.5	70.5	62.1	62.5	63.7	58.2	60.8				67.2			72.9	66.9
11	62.7		66.5		63.3	65.5	70.5	72.5	66.4			58.5		64.5	59.4	68.1
12	66.5	64.9	76.5			62.5	70.5									69.8
13	66.5	62.5				68.0	70.5			70.5		82.5				71.5
14	70.5		65.9												68.5	71.2
15																72.1
16													58.5			58.5
17																

Table 16. 4X Haddock summer RV survey Scotian Shelf strata 470-481 - Mean weight-at-age (kg).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0								0.006		0.004	0.003	0.004	0.002	0.003	0.005
1	0.078	0.083	0.076	0.098	0.089	0.099	0.079	0.101	0.064	0.073	0.079	0.042	0.053	0.045	0.052
2	0.378	0.243	0.196	0.278	0.303	0.312	0.290	0.431	0.371	0.264	0.326	0.250	0.138	0.145	0.138
3	0.715	0.678	0.627	0.446	0.612	0.695	0.559	0.793	0.780	0.501	0.619	0.687	0.474	0.372	0.315
4	0.976	1.017	1.228	1.224	0.916	1.160	1.122	1.154	1.261	1.114	1.155	1.069	0.988	0.849	0.636
5	1.353	1.368	1.615	1.653	1.678	1.719	1.417	1.646	1.721	1.525	1.616	1.610	1.342	1.390	1.061
6	1.611	1.515	1.937	2.230	2.130	2.157	1.969	1.888	2.129	2.123	1.981	2.058	1.823	1.683	1.612
7	2.051	1.692	1.975	2.270	2.511	2.859	2.462	2.753	2.544	2.422	2.466	2.358	2.171	2.198	1.888
8	2.581	1.990	2.397	2.446	2.651	3.012	2.324	3.021		2.596	2.665	2.993	2.661	2.312	2.134
9	2.828	2.610	2.728	2.590	2.736	3.147		3.800		3.627	3.144	3.202	3.377	2.538	2.412
10	3.676	3.555	3.056	2.868	2.625	3.804		2.961			3.297	3.498		2.563	
11	3.794	3.543	3.704	3.427	3.218	3.587			2.795		3.767	3.931	3.140	2.341	
12	2.582	3.957	5.243			3.381	2.839	3.328						4.195	
13							3.124	3.901						3.627	
14								3.240							
15										3.508					
16															
17															

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
0		0.002		0.002	0.010					0.007	0.006	0.009	0.006	0.008	0.009	0.005
1	0.068	0.065	0.071	0.058	0.079	0.108	0.082	0.071	0.103	0.108	0.057	0.053	0.089	0.060	0.097	0.075
2	0.231	0.249	0.265	0.323	0.288	0.309	0.404	0.284	0.306	0.351	0.267	0.174	0.212	0.209	0.165	0.274
3	0.376	0.468	0.508	0.603	0.659	0.678	0.652	0.633	0.609	0.603	0.584	0.466	0.350	0.367	0.442	0.566
4	0.660	0.572	0.707	0.771	0.745	0.959	1.014	0.947	0.952	0.941	0.937	0.759	0.628	0.491	0.534	0.929
5	0.872	0.895	0.864	1.012	1.068	1.317	1.255	1.204	1.185	1.118	1.171	0.930	0.932	0.737	0.675	1.285
6	1.146	1.087	1.081	1.014	1.298	1.379	1.687	1.648	1.530	1.224	1.283	1.265	1.015	0.974	0.852	1.603
7	1.550	1.309	1.334	1.169	1.253	1.353	1.665	1.801	1.614	1.407	1.467	1.409	1.284	1.182	0.926	1.877
8	1.760	1.651	1.450	1.351	1.321	1.504	1.649	1.540	1.599	1.726	1.742	1.441	1.603	1.518	1.126	2.059
9	1.850	2.033	1.674	1.445	1.416	1.725	1.450	1.481	1.317	1.529	2.152	1.734	1.578	1.401	1.122	2.279
10	2.240	2.097	1.872	1.446	1.692	1.302	1.256	2.477	1.949	1.637		1.215	1.579	1.622	1.371	2.360
11		2.908	2.114	2.258	1.769	2.099	2.598	2.049	1.530	2.032		1.971	2.209	1.942	1.646	2.727
12		3.230		2.684	1.357	1.696	2.030	2.494	1.796	1.376	1.581	2.081	2.455	1.620	1.726	2.626
13		2.339						3.276	1.784	1.420		1.419			1.395	2.611
14	2.927				3.092	3.156	3.316		4.174							3.317
15																3.506
16																
17							2.757									2.757

Table 17. 4X Haddock summer RV survey Bay of Fundy strata 482-495 - Mean weight-at-age (kg).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0										0.002				0.006	
1	0.108		0.057	0.151	0.100	0.118	0.136	0.134	0.081	0.093	0.137	0.113	0.117	0.122	0.150
2	0.448	0.369		0.324	0.340	0.539	0.410	0.600	0.605	0.423	0.464	0.409	0.347	0.390	0.342
3	0.770	0.935	1.015	0.659	0.801	1.085	0.842	1.108	1.161	0.924	0.875	0.796	0.759	0.804	0.524
4	1.132	1.311	1.546	1.541	1.282	1.470	1.272	1.597	1.717	1.588	1.476	1.387	1.398	1.333	1.067
5	1.365	1.610	1.882	2.054	2.349	1.789	1.766	2.146	2.115	2.288	2.037	2.296	1.934	2.002	1.532
6	1.492	1.714	2.176	2.515	2.903	3.142	2.463	2.512	2.420	2.758	2.690	2.788	2.592	2.524	2.049
7	1.938	1.864	2.407	2.501	2.518		3.217	3.418	2.879	3.094	2.749	3.183	3.103	2.872	2.521
8	2.263	2.437	2.670	2.412	3.159		2.981	3.392	3.390	3.510	2.809	2.681	3.567	3.168	2.739
9	2.235	2.732	2.986	2.964	2.753		2.875	3.795		4.323	3.387	3.650	3.616	3.199	3.194
10	2.746	4.511	4.325	2.789	3.309	2.978	2.981	3.148		3.729		4.592	4.605	3.759	3.588
11	3.605				3.797	3.151	3.845	3.287				4.174	4.866	4.235	3.756
12		4.304				3.301	3.139	5.067	3.769			4.528		3.164	4.084
13			5.354	3.765			3.717	4.417	4.487					4.828	3.153
14								4.597	4.611	4.343					
15									4.081	4.619					
16															
17															

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
0		0.003				0.008				0.006	0.004	0.005	0.007	0.007	0.006	0.005
1	0.147	0.148	0.172	0.161	0.114		0.149	0.123	0.119	0.166	0.079	0.095	0.129	0.097	0.125	0.123
2	0.494	0.541	0.586	0.547	0.490	0.575	0.889	0.466	0.597	0.503	0.422	0.282	0.305	0.391	0.347	0.468
3	0.822	1.007	1.071	1.129	0.763	1.101	1.122	0.444	0.967	1.098	0.917	0.761	0.620	0.681	0.859	0.882
4	1.095	1.377	1.502	1.436	1.339	1.698	1.628	1.589	1.422	1.683	1.357	1.385	1.037	0.983	1.120	1.402
5	1.526	1.541	1.713	1.812	1.586	1.885	1.758	2.148	1.765	3.620	1.924	1.834	1.581	1.303	1.227	1.902
6	2.453	2.003	2.600	2.023	1.915	2.205	2.486	2.149	2.096	2.526	2.152	1.985	2.053	1.785	1.398	2.317
7	2.704	2.115	2.497	2.872	2.073	2.352	2.609	2.619	2.359	2.770	2.374	2.239	2.153	1.890	1.677	2.567
8	2.802	1.946	2.159	2.320	1.712	2.830	2.798	2.411	2.207	3.198	2.483	2.379	3.772	2.171	2.287	2.727
9	2.673	2.872	3.059	3.292	2.670	2.982	3.012	3.250			3.516	2.743	3.776	2.297	2.353	3.114
10	3.125	2.748	3.776	2.632	2.670	2.815	2.112	2.379				3.098			4.092	3.292
11	2.555		3.168		2.770	3.053	3.738	4.007	2.871			2.042		2.743	2.185	3.426
12	3.038	2.934	4.827			2.658	3.738									3.735
13	3.038	2.625				3.395	3.738			3.620		5.747				3.991
14	3.614		3.077												3.382	4.048
15																4.350
16													2.054			2.054
17													2.054			2.054

Table 18. 4X Haddock summer RV survey strata 470-495 - Mean weight-at-age (kg).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.079	0.083	0.076	0.098	0.091	0.100	0.089	0.104	0.064	0.077	0.081	0.086	0.056	0.061	0.094
2	0.380	0.246	0.196	0.286	0.307	0.360	0.343	0.451	0.408	0.340	0.402	0.388	0.214	0.232	0.277
3	0.722	0.739	0.652	0.483	0.673	0.746	0.654	0.807	0.876	0.747	0.737	0.769	0.632	0.525	0.431
4	1.027	1.071	1.279	1.318	0.988	1.230	1.161	1.200	1.429	1.327	1.288	1.156	1.270	1.045	0.781
5	1.358	1.402	1.834	1.782	1.740	1.724	1.545	1.721	1.861	1.761	1.770	1.836	1.669	1.563	1.231
6	1.560	1.556	1.971	2.300	2.278	2.299	2.039	1.988	2.183	2.408	2.108	2.350	2.323	1.880	1.811
7	1.984	1.722	2.020	2.354	2.513	2.859	2.598	2.838	2.633	2.737	2.475	2.725	2.882	2.391	2.139
8	2.387	2.141	2.470	2.433	2.700	3.012	2.414	3.066	3.390	3.159	2.679	2.931	3.433	2.720	2.438
9	2.551	2.653	2.851	2.721	2.740	3.147	2.875	3.797		4.151	3.186	3.391	3.572	2.851	2.999
10	3.227	3.751	3.756	2.823	2.839	3.461	2.981	3.074		3.729	3.297	4.259	4.605	3.184	3.588

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1970-98
1	0.074	0.066	0.100	0.096	0.083	0.108	0.086	0.078	0.103	0.140	0.062	0.054	0.113	0.061	0.100	0.085
2	0.306	0.262	0.353	0.438	0.342	0.414	0.566	0.308	0.353	0.410	0.345	0.203	0.225	0.259	0.172	0.331
3	0.518	0.580	0.554	0.681	0.711	0.800	0.816	0.628	0.746	0.815	0.787	0.648	0.414	0.395	0.532	0.665
4	0.700	0.731	0.940	0.981	0.862	1.301	1.298	1.117	1.061	1.223	1.144	1.183	0.770	0.600	0.597	1.066
5	0.989	0.959	1.140	1.343	1.248	1.720	1.483	1.631	1.375	1.315	1.452	1.432	1.172	1.057	0.801	1.479
6	1.342	1.164	1.123	1.310	1.495	1.806	2.091	1.988	1.758	1.596	1.550	1.675	1.340	1.436	0.951	1.818
7	1.965	1.399	1.438	1.558	1.500	2.079	2.128	2.179	1.903	1.858	1.795	1.873	1.627	1.681	1.141	2.133
8	1.998	1.656	1.650	1.623	1.509	2.145	2.050	1.710	1.823	2.327	2.127	1.952	2.050	2.040	1.307	2.346
9	1.933	2.277	2.091	1.860	1.536	2.370	1.857	1.798	1.317	1.529	2.863	2.502	1.885	1.852	1.327	2.541
10	2.530	2.312	1.949	1.782	1.852	1.604	1.655	2.397	1.949	1.637		2.371	1.579	1.622	1.892	2.734

Table 19. 4X Haddock length-weight relationship from the summer RV survey all strata 470-481 and predicted weight-at-lengths of 35 and 50cm.

Years	Cases	Intercept	s.e.	Alpha	Beta	s.e.	Corr	35	50
1970	1170	-5.67561	0.03800	3.43E-06	3.29839	0.01053	0.99410	0.425	1.377
1971	881	-4.94320	0.04668	7.13E-06	3.09304	0.01268	0.99260	0.426	1.283
1972	849	-5.08481	0.03836	6.19E-06	3.14701	0.01040	0.99540	0.448	1.375
1973	603	-4.81151	0.04017	8.14E-06	3.07307	0.01107	0.99610	0.452	1.353
1974	1216	-4.89981	0.03489	7.45E-06	3.09214	0.00963	0.99410	0.443	1.335
1975	585	-5.13923	0.05373	5.86E-06	3.15367	0.01449	0.99390	0.434	1.337
1976	834	-5.07340	0.04260	6.26E-06	3.12595	0.01181	0.99410	0.420	1.281
1977	789	-4.93072	0.04157	7.22E-06	3.10174	0.01118	0.99490	0.445	1.344
1978	741	-5.14638	0.04885	5.82E-06	3.16360	0.01329	0.99350	0.446	1.380
1979	725	-4.85644	0.05004	7.78E-06	3.08015	0.01341	0.99320	0.443	1.330
1980	669	-4.74648	0.04184	8.68E-06	3.05021	0.01121	0.99550	0.445	1.321
1981	526	-5.28814	0.05352	5.05E-06	3.18750	0.01420	0.99480	0.422	1.315
1982	470	-4.87478	0.05507	7.64E-06	3.07984	0.01530	0.99420	0.435	1.305
1983	635	-5.26714	0.05512	5.16E-06	3.16367	0.01486	0.99300	0.396	1.223
1984	563	-4.95404	0.05121	7.05E-06	3.08990	0.01414	0.99410	0.416	1.254
1985	613	-4.67710	0.05913	9.31E-06	3.01603	0.01624	0.99120	0.422	1.239
1986	628	-5.19212	0.06055	5.56E-06	3.15640	0.01655	0.99150	0.416	1.282
1987	518	-4.75814	0.07767	8.58E-06	3.05097	0.02077	0.98820	0.441	1.309
1988	453	-5.11456	0.06094	6.01E-06	3.14609	0.01652	0.99380	0.433	1.330
1989	477	-4.89684	0.05723	7.47E-06	3.08143	0.01598	0.99360	0.428	1.284
1990	610	-4.50832	0.06592	1.10E-05	2.99375	0.01778	0.98940	0.462	1.344
1991	582	-4.85403	0.04498	7.80E-06	3.06626	0.01207	0.99550	0.423	1.263
1992	506	-4.47921	0.04841	1.13E-05	2.97472	0.01322	0.99500	0.445	1.284
1993	433	-4.80374	0.04659	8.20E-06	3.04823	0.01283	0.99620	0.417	1.238
1994	795	-4.78877	0.02478	8.32E-06	3.04872	0.00718	0.99780	0.424	1.259
1995	785	-4.74684	0.02743	8.68E-06	3.02952	0.00795	0.99730	0.413	1.218
1996	886	-4.76864	0.02809	8.49E-06	3.03631	0.00803	0.99690	0.414	1.224
1997	808	-4.63425	0.03490	9.71E-06	3.00841	0.00982	0.99570	0.429	1.255
1998	731	-4.86934	0.03253	7.68E-06	3.06621	0.00929	0.99660	0.417	1.244
1999	958	-4.78499	0.01914	8.35E-06	3.05298	0.00561	0.99830	0.432	1.285
1970-98				7.48E-06	3.09045			0.430	1.296

Table 20. 4X Haddock length-weight relationship from the summer RV survey all strata 482-495 and predicted weight-at-lengths of 35 and 50cm.

Years	Cases	Intercept	s.e.	Alpha	Beta	s.e.	Corr	35	50
1970	192	-4.84784	0.16311	7.85E-06	3.08453	0.04118	0.98340	0.454	1.365
1971	173	-4.78335	0.15523	8.37E-06	3.06155	0.03933	0.98610	0.447	1.331
1972	165	-4.10847	0.13032	1.64E-05	2.90943	0.03275	0.98980	0.511	1.441
1973	283	-4.72857	0.06679	8.84E-06	3.04590	0.01803	0.99510	0.446	1.322
1974	327	-5.13974	0.07393	5.86E-06	3.15425	0.01962	0.99370	0.435	1.339
1975	179	-4.60715	0.09180	9.98E-06	3.02545	0.02396	0.99440	0.468	1.378
1976	424	-4.36030	0.05877	1.28E-05	2.94491	0.01582	0.99390	0.450	1.287
1977	401	-4.86907	0.07482	7.68E-06	3.08937	0.01925	0.99230	0.452	1.362
1978	359	-4.74679	0.10380	8.68E-06	3.07119	0.02657	0.98690	0.479	1.433
1979	520	-5.08693	0.05382	6.18E-06	3.14298	0.01393	0.99490	0.440	1.351
1980	440	-4.27254	0.07741	1.39E-05	2.93847	0.02011	0.98990	0.480	1.370
1981	278	-4.44565	0.09178	1.17E-05	2.98404	0.02330	0.99160	0.475	1.377
1982	462	-4.59614	0.06524	1.01E-05	3.02230	0.01681	0.99290	0.468	1.376
1983	231	-4.60286	0.09391	1.00E-05	3.01689	0.02405	0.99280	0.456	1.338
1984	417	-4.51478	0.07651	1.09E-05	2.99508	0.02001	0.99080	0.461	1.342
1985	248	-4.44728	0.09401	1.17E-05	2.97016	0.02414	0.99190	0.452	1.303
1986	212	-4.39991	0.15506	1.23E-05	2.96792	0.03967	0.98170	0.470	1.354
1987	178	-4.55286	0.12457	1.05E-05	3.00528	0.03209	0.99010	0.460	1.345
1988	205	-4.75983	0.09095	8.57E-06	3.05998	0.02350	0.99400	0.455	1.354
1989	150	-4.52654	0.09037	1.08E-05	3.00259	0.02425	0.99520	0.468	1.366
1990	211	-4.16191	0.11703	1.56E-05	2.91333	0.02961	0.98930	0.491	1.387
1991	236	-4.46614	0.09837	1.15E-05	2.98252	0.02507	0.99180	0.463	1.342
1992	149	-4.38790	0.09272	1.24E-05	2.96101	0.02368	0.99530	0.464	1.334
1993	107	-3.98560	0.10592	1.86E-05	2.84814	0.02746	0.99510	0.464	1.282
1994	187	-4.47634	0.04997	1.14E-05	2.97741	0.01381	0.99800	0.450	1.302
1995	423	-4.68354	0.04373	9.25E-06	3.01920	0.01189	0.99670	0.424	1.246
1996	367	-4.62859	0.05694	9.77E-06	3.01057	0.01519	0.99530	0.435	1.273
1997	300	-4.44504	0.07551	1.17E-05	2.96690	0.02008	0.99320	0.447	1.289
1998	293	-4.49576	0.05423	1.12E-05	2.97899	0.01469	0.99640	0.444	1.284
1999	311	-4.83193	0.03464	7.97E-06	3.06568	0.00969	0.99840	0.432	1.288
1970-98				1.08E-05	3.00518			0.459	1.340

Table 21. Mean number of haddock per standard tow by stratum from the Research Vessel Survey July 5 - 17, 1999 and the ITQ Survey, June 28 - July 9, 1999.

	RV Survey			ITQ Survey		
Stratum	Sets	Mean	St. Dev	Sets	Mean	St. Dev.
470	2	0.97	0.00	7	3.78	2.58
471	2	5.34	2.02	3	1.06	1.06
472	4	194.46	232.92	12	104.33	113.41
473	2	85.43	59.67	2	30.69	1.50
474	2	58.35	72.68	2	128.05	86.80
475	2	65.12	9.15	2	127.52	0.75
476	4	19.05	11.54	16	40.95	85.94
477	5	213.79	131.62	11	263.20	245.86
478	2	6.14	8.68	1	16.93	
480	8	1022.21	1310.64	8	1477.08	1268.62
481	9	274.05	157.17	19	228.49	257.76
482	3	19.44	13.50	7	11.26	9.52
483	2	4.22	3.14			
484	3	3.73	3.32	9	3.44	3.93
485	3	84.82	63.93	18	67.31	97.15
490	3	62.71	41.45	10	424.71	542.51
491	3	38.49	23.78	4	65.96	110.55
492	3	7.05	6.82	7	130.58	281.44
493	2	5.90	8.34	6	4.71	7.01
494	2	29.51	37.26	4	9.42	18.85
495	2	61.06	50.99	7	74.04	69.95
Inshore				29	363.89	618.35

Table 22. Mean weight of haddock per standard tow by stratum from the Research Vessel Survey July 5 - 17, 1999 and the ITQ Survey, June 28 - July 9, 1999.

	RV Survey			ITQ Survey		
Stratum	Sets	Mean	St. Dev	Sets	Mean	St. Dev.
470	2	0.37	0.50	7	3.02	2.15
471	2	3.56	1.88	3	0.71	0.61
472	4	11.05	7.28	12	38.72	42.69
473	2	59.20	38.13	2	25.93	5.24
474	2	2.82	2.04	2	116.94	93.54
475	2	29.03	9.01	2	46.03	38.16
476	4	10.60	9.78	16	18.14	43.02
477	5	53.49	26.61	11	64.88	47.74
478	2	5.85	8.27	1	11.64	
480	8	289.32	237.41	8	258.72	5.32
481	9	92.01	49.63	19	49.70	41.41
482	3	4.84	4.81	7	9.54	9.37
483	2	8.50	2.01			
484	3	0.25	0.40	9	6.58	7.98
485	3	48.62	45.55	18	56.61	82.11
490	3	32.07	33.33	10	186.71	210.86
491	3	44.85	13.03	4	80.77	127.71
492	3	16.15	14.21	7	44.04	56.39
493	2	0.10	0.14	6	7.63	11.32
494	2	6.73	5.03	4	9.76	19.52
495	2	42.95	47.31	7	60.39	50.40
Inshore				29	94.50	191.06

Table 23. 4X haddock total numbers-at-length (000's) from the ITQ Survey by year and area.

	1995			1996			1997			1998			1999		
strata	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6.5	0	0	0	2	5	0	1	0	0	1	0	0	42	0	15
8.5	1	0	0	34	71	10	2	0	0	0	2	3	243	11	32
10.5	7	0	0	46	94	17	0	0	0	19	1	2	254	8	26
12.5	23	1	10	5	11	0	1	0	0	24	1	10	60	2	14
14.5	597	19	176	40	83	9	1	4	4	187	1	39	38	13	86
16.5	2658	60	684	283	581	13	48	18	23	625	27	89	435	20	290
18.5	4023	164	1014	602	1236	60	369	87	68	860	80	138	2593	99	798
20.5	2378	292	1077	428	905	117	818	258	133	423	120	167	5423	407	2072
22.5	742	160	591	476	1019	166	456	282	132	100	71	168	3609	1026	2226
24.5	251	75	211	1119	2421	412	292	270	63	116	26	66	1540	902	1267
26.5	207	46	146	1399	3225	529	335	178	78	455	49	270	952	442	418
28.5	572	44	328	993	2469	405	475	67	122	700	118	627	865	109	347
30.5	1098	204	974	526	1440	254	884	176	183	619	277	710	998	119	358
32.5	1160	466	1319	265	756	117	1147	328	271	635	415	648	793	320	411
34.5	634	639	1186	430	1042	109	903	567	289	806	348	581	740	431	426
36.5	328	550	817	831	1932	170	556	663	210	883	264	532	847	335	311
38.5	457	297	437	842	2014	205	541	522	123	707	259	409	861	260	331
40.5	406	161	277	579	1562	193	592	637	142	508	403	350	561	436	306
42.5	295	188	234	388	1199	127	493	533	157	408	440	211	342	479	281
44.5	171	186	177	311	1040	90	376	517	149	331	451	134	268	562	208
46.5	197	182	93	235	804	65	240	477	127	163	343	45	169	480	159
48.5	131	124	57	168	552	41	135	374	94	86	274	27	152	393	133
50.5	114	86	45	121	427	17	89	295	55	76	164	31	76	262	41
52.5	82	56	41	96	326	14	66	209	24	32	108	2	36	149	36
54.5	87	59	45	63	195	15	49	107	26	28	85	2	26	108	0
56.5	60	34	42	53	168	9	22	66	11	15	37	8	12	48	13
58.5	36	28	29	34	112	2	20	27	3	7	30	0	10	23	1
60.5	13	26	16	16	61	6	9	23	1	1	18	0	4	25	0
62.5	11	22	11	8	29	1	4	10	0	2	15	0	2	8	0
64.5	1	16	2	8	27	3	3	9	0	1	11	0	3	7	0
66.5	1	8	1	1	5	0	1	7	0	2	5	1	3	3	0
68.5	0	3	2	0	1	1	0	0	0	0	4	0	1	4	0
70.5	1	3	1	1	9	0	0	6	0	0	3	0	0	1	0
72.5	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0
74.5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
76.5	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0
78.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 24. 4X haddock ITQ Survey total numbers-at-age (000's).

	Scotian Shelf RV Strata (470-481)					Bay of Fundy RV Strata (482-495)					Inshore					Total All Sets				
	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999
0	8	88	3	44	620	0	0	0	3	28	0	27	0	6	130	8	115	3	53	778
1	10546	1181	1596	2184	10698	822	22	1080	326	2999	3956	123	532	678	7441	15324	1327	3207	3188	21137
2	3637	4715	1196	1538	5710	2239	1797	411	1526	1200	5088	2098	345	3396	1542	10964	8610	1952	6460	8492
3	1510	2499	3222	1114	1722	798	2106	2851	320	1408	756	869	1057	348	856	3064	5474	7129	1782	3986
4	478	1125	1860	2663	1048	193	648	1872	1266	321	145	109	472	689	143	816	1883	4205	4618	1511
5	231	557	595	788	1159	59	123	382	803	960	50	16	74	172	317	340	695	1052	1763	2436
6	101	137	252	188	529	23	32	3	69	338	14	4	8	3	136	138	173	328	260	1003
7	176	112	75	106	227	48	19	47	68	184	23	4	3	5	38	247	134	125	178	449
8	43	141	29	40	96	14	22	0	52	23	10	3	0	4	1	67	166	29	96	121
9	5	23	55	29	83	5	7	3	11	19	1	0	0	0	3	10	31	58	39	105
10	1	31	37	31	20	3	5	0	1	3	0	0	0	0	0	4	35	37	32	22
11	0	3	4	8	18	0	3	0	6	7	0	0	0	0	0	0	7	4	14	25
12	3	7	5	3	20	0	0	0	0	0	0	0	0	0	0	3	7	5	3	20
13	0	6	1	0	10	0	0	0	0	0	1	0	0	0	0	1	6	1	0	11
14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
15	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
16	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	4	0	0
Tot.	16739	10626	8930	8736	21960	4204	4784	6717	4451	7491	10044	3253	2491	5301	10607	30986	18664	18139	18486	40097

Table 25. SPA Results

A. Residuals

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	0.07	0.36	-2.09	0.48	0.52	-0.67	-0.85	0.90	-0.60	0.06	-0.37	0.80	0.71	-0.88	0.60
3	-0.60	0.26	-0.69	-0.96	0.98	-0.84	-0.42	1.46	-0.25	-0.13	0.21	-0.35	0.13	0.11	0.13
4	-0.32	0.14	-0.46	-0.39	-0.49	-0.09	-0.73	1.31	-0.89	-0.06	0.07	0.07	-0.37	-0.20	0.67
5	-0.34	0.20	-0.46	0.01	0.22	-1.17	0.26	0.97	-0.65	-0.22	0.58	-0.18	0.57	-0.28	0.24
6	0.23	0.29	-0.49	-0.56	0.07	-0.17	-0.34	1.22	-0.14	0.09	0.39	0.23	0.41	0.17	0.29
7	-0.48	0.31	-0.26	-0.23	-0.14	-0.15	-0.39	0.96	0.07	0.50	0.28	-0.01	1.12	-0.03	1.03
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg 2-7	-0.12	0.13	-0.37	-0.14	0.10	-0.26	-0.21	0.57	-0.20	0.02	0.10	0.05	0.22	-0.09	0.25

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	0.67	1.01	-0.13	-0.20	0.29	0.38	-0.58	-0.24	-1.30	0.16	0.78	0.58	0.11	-0.28	-0.33
3	0.60	0.47	-0.15	-0.47	-0.24	0.30	0.59	-0.92	-0.55	-0.56	0.87	0.78	0.33	-0.13	0.03
4	0.18	0.45	0.14	-0.12	-0.30	-0.17	0.76	0.37	-1.12	-0.21	0.25	1.14	0.26	0.01	0.11
5	0.90	-0.07	-0.42	0.46	0.10	0.42	0.36	0.38	-0.70	-1.48	-0.05	0.63	0.17	-0.15	-0.32
6	0.36	0.53	-0.30	-0.17	-0.56	0.35	0.69	-0.26	-0.74	-0.33	-0.63	0.12	-0.29	-0.20	-0.29
7	0.49	0.14	-0.36	-0.55	-0.45	0.37	0.49	-0.05	-1.79	-0.49	-0.25	0.06	-0.65	-0.08	0.54
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.08	-0.36	0.17	-0.48
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.07	0.05	-0.30	-0.15
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.32	0.28	0.20	-0.03	-0.12
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25	0.14	0.35	-0.08	-0.16
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.24	-0.04	0.21	-0.07	0.14
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.12	-0.13	-0.24	-0.24	0.73
Avg 2-7	0.27	0.21	-0.10	-0.09	-0.10	0.14	0.19	-0.06	-0.52	-0.24	0.08	0.31	0.01	-0.12	-0.03

Mean Square of the Residuals = 0.30932

	Est. Param	CV
1	10.5267	0.425467
2	9.76136	0.304683
3	8.82243	0.253879
4	9.77308	0.22895
5	9.17611	0.230623
6	7.44601	0.268197
7	0.000395156	0.106581
8	0.000490392	0.105198
9	0.000555677	0.104642
10	0.000666367	0.104588
11	0.000778532	0.10494
12	0.000928758	0.105583
13	0.000263831	0.293704
14	0.000250391	0.27757
15	0.000215529	0.272229
16	0.00015818	0.270889
17	9.92434E-005	0.274635
18	0.000136294	0.283165

Table 25. SPA Results (cont.)

B. Population Numbers (000's)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	25472	6048	47504	44334	24267	49862	53229	30498	41285	32459	41349	44110	34473	42328	15917
2	12023	20855	4951	38855	36160	19867	40790	43564	24968	33801	26575	33839	36113	28224	34655
3	5647	8859	16343	4034	28994	28960	14277	32214	34500	20372	27599	21609	26610	29091	23044
4	7490	3947	5751	10222	3199	19410	19532	10189	23536	25122	15608	20337	15640	18262	20541
5	2454	4731	2500	3015	6312	2332	11169	12105	6509	12736	14359	9999	10888	10408	9504
6	2789	1655	2552	1579	1492	3513	1465	5786	7012	3379	6835	6755	4296	4432	4808
7	13979	1794	980	1497	810	748	1867	804	2121	3103	1776	2364	2570	1868	1408
8	5493	7211	1405	719	676	487	386	793	331	768	1389	967	857	693	594
9	697	2758	2824	1098	294	303	242	176	296	144	385	562	461	373	174
10	250	446	1311	1240	662	68	191	133	47	142	65	159	160	200	119
1-10	76292	58304	86120	106592	102865	125550	143149	136262	140606	132025	135940	140701	132069	135879	110765

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	11242	5665	8528	23544	23709	7980	10369	12762	16725	39709	47235	14058	28837	48817	15263
2	13030	9204	4638	6982	19264	19399	6534	8486	10441	13673	32502	38671	11510	23609	39968
3	27683	10462	7267	3715	5523	15601	15518	5303	6820	8422	11106	26521	31627	9412	19302
4	17786	20760	7519	5004	2578	4072	11486	11525	4122	4942	6562	8407	20982	25418	7571
5	12252	12340	12582	3412	3178	1659	2978	7277	7153	2904	3474	4745	5985	15662	19859
6	4426	5816	6463	6148	1983	1755	1034	1913	3885	4202	2082	2286	3267	3988	11199
7	1599	2259	3392	3393	3253	1343	1009	624	1359	2213	2562	1489	1485	2264	2236
8	228	849	1645	2513	1990	2011	745	546	287	959	1569	1691	898	972	1368
9	155	63	606	1294	1248	1213	1055	430	147	139	763	903	988	610	498
10	35	80	19	490	723	566	743	583	137	55	98	478	418	709	336
1-10	88436	67499	52659	56495	63448	55600	51472	49448	51077	77218	107952	99251	105996	131462	117600

C. Fishing Mortality

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.11	0.04	0.01	0.09	0.02	0.13	0.04	0.03	0.00	0.00	0.01	0.04	0.02	0.00	0.02
3	0.16	0.23	0.27	0.03	0.20	0.19	0.14	0.11	0.12	0.07	0.11	0.12	0.18	0.15	0.06
4	0.26	0.26	0.45	0.28	0.12	0.35	0.28	0.25	0.41	0.36	0.25	0.42	0.21	0.45	0.32
5	0.19	0.42	0.26	0.50	0.39	0.26	0.46	0.35	0.46	0.42	0.55	0.64	0.70	0.57	0.56
6	0.24	0.32	0.33	0.47	0.49	0.43	0.40	0.80	0.62	0.44	0.86	0.77	0.63	0.95	0.90
7	0.46	0.04	0.11	0.59	0.31	0.46	0.66	0.69	0.82	0.60	0.41	0.81	1.11	0.95	1.62
8	0.49	0.74	0.05	0.69	0.60	0.50	0.59	0.79	0.64	0.49	0.71	0.54	0.63	1.18	1.15
9	0.25	0.54	0.62	0.31	1.27	0.26	0.40	1.12	0.53	0.60	0.68	1.05	0.63	0.94	1.39
10	0.57	0.53	0.57	0.79	0.61	0.73	0.79	0.89	0.97	0.76	0.87	1.13	1.14	1.23	1.39
5-7	0.30	0.26	0.23	0.52	0.39	0.39	0.50	0.61	0.63	0.49	0.61	0.74	0.81	0.82	1.03

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.04	0.02	0.03	0.01	0.02	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3	0.09	0.13	0.17	0.17	0.10	0.11	0.10	0.05	0.12	0.05	0.08	0.03	0.02	0.02	0.00
4	0.17	0.30	0.59	0.25	0.24	0.11	0.26	0.28	0.15	0.15	0.12	0.14	0.09	0.05	0.01
5	0.55	0.45	0.52	0.34	0.39	0.27	0.24	0.43	0.33	0.13	0.22	0.17	0.21	0.14	0.03
6	0.47	0.34	0.44	0.44	0.19	0.35	0.31	0.14	0.36	0.29	0.14	0.23	0.17	0.38	0.05
7	0.43	0.12	0.10	0.33	0.28	0.39	0.42	0.58	0.15	0.14	0.22	0.31	0.22	0.30	0.16
8	1.08	0.14	0.04	0.50	0.29	0.45	0.35	1.11	0.53	0.03	0.35	0.34	0.19	0.47	0.10
9	0.45	0.98	0.01	0.38	0.59	0.29	0.39	0.94	0.79	0.15	0.27	0.57	0.13	0.40	0.10
10	0.69	0.55	0.74	0.63	0.49	0.50	0.53	0.60	0.45	0.31	0.31	0.35	0.28	0.35	0.10
5-7	0.48	0.30	0.35	0.37	0.29	0.34	0.32	0.38	0.28	0.19	0.19	0.24	0.20	0.27	0.08

Table 25. SPA Results (cont.)

D. Biomass (t)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	1136	270	2568	1744	1341	2281	2865	1197	2162	909	1396	1630	1884	1163	455
2	3280	2902	632	5735	6266	3594	7553	8702	5141	5001	4679	5996	4899	3213	4503
3	3345	4698	6542	1241	12721	13853	6924	16962	21674	11254	13818	12017	13175	9749	7279
4	6581	3470	5594	9476	2211	17662	18175	9025	25280	27083	15312	18778	15460	14841	13158
5	3114	5675	3307	4553	9557	3044	15396	17113	9727	20207	22002	15373	15126	14666	10780
6	4142	2406	4243	3060	3005	7025	2748	10140	13593	7151	13171	13776	8870	7850	8090
7	26696	2941	1737	3224	1947	1909	4563	1934	4853	7584	4335	5665	6688	4401	2823
8	12511	14860	2897	1595	1704	1340	1015	2237	1028	2215	3761	2605	2623	1940	1434
9	1466	6955	6976	2846	760	884	711	532	1460	539	1222	1692	1491	1166	498
10	731	1381	4138	3517	1839	209	586	396	168	776	240	587	634	675	381
1-10	63002	45558	38633	36993	41350	51800	60537	68239	85085	82719	79935	78118	70851	59665	49401
SSB	55241	37688	28892	28271	21023	32073	43194	41377	56109	65555	60043	58476	50892	45539	37164

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	590	222	244	1129	1209	295	489	584	616	2059	4206	483	755	3646	0
2	2215	1280	709	1464	3491	3591	1615	1383	1734	2814	7143	4336	1263	4036	4102
3	10487	4408	2769	1822	3083	8157	9025	3160	3268	4513	6309	12545	9161	2802	7159
4	9764	12773	5554	3690	1976	3916	11705	11006	3364	4721	6333	8114	14816	12664	3674
5	10660	10109	11488	3834	3516	2021	4136	10586	8866	3431	4629	6072	7049	14122	13758
6	5689	6178	6707	7513	2810	2634	1961	3285	6580	6225	2972	3566	4526	5175	11224
7	3017	3096	4388	4488	4559	2367	1979	1332	2644	4000	4336	2537	2451	3397	2862
8	471	1532	2499	3839	3051	3608	1539	1041	572	2017	3118	3166	1759	1771	2028
9	336	135	1128	2266	1971	2295	2105	825	221	232	1969	2084	1894	1189	820
10	97	170	41	946	1341	889	1472	1229	257	80	172	1245	832	1240	628
1-10	43325	39905	35527	30991	27007	29772	36025	34432	28122	30092	41188	44148	44507	50042	46255
SSB	30034	33993	31805	26576	19224	17730	24897	29304	22504	20706	23529	26784	33327	39558	34994

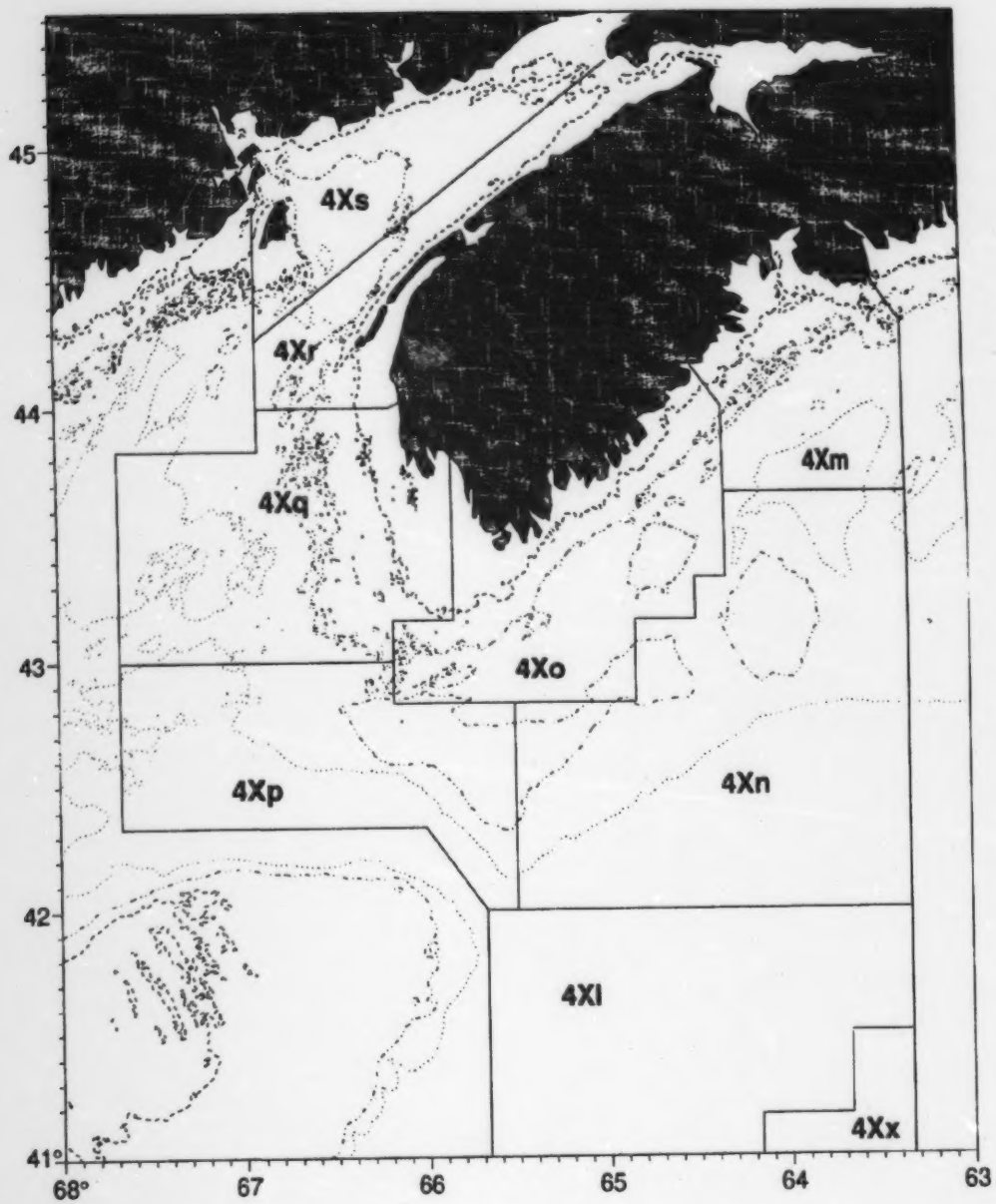


Figure 1. Unit areas in NAFO Division 4X.

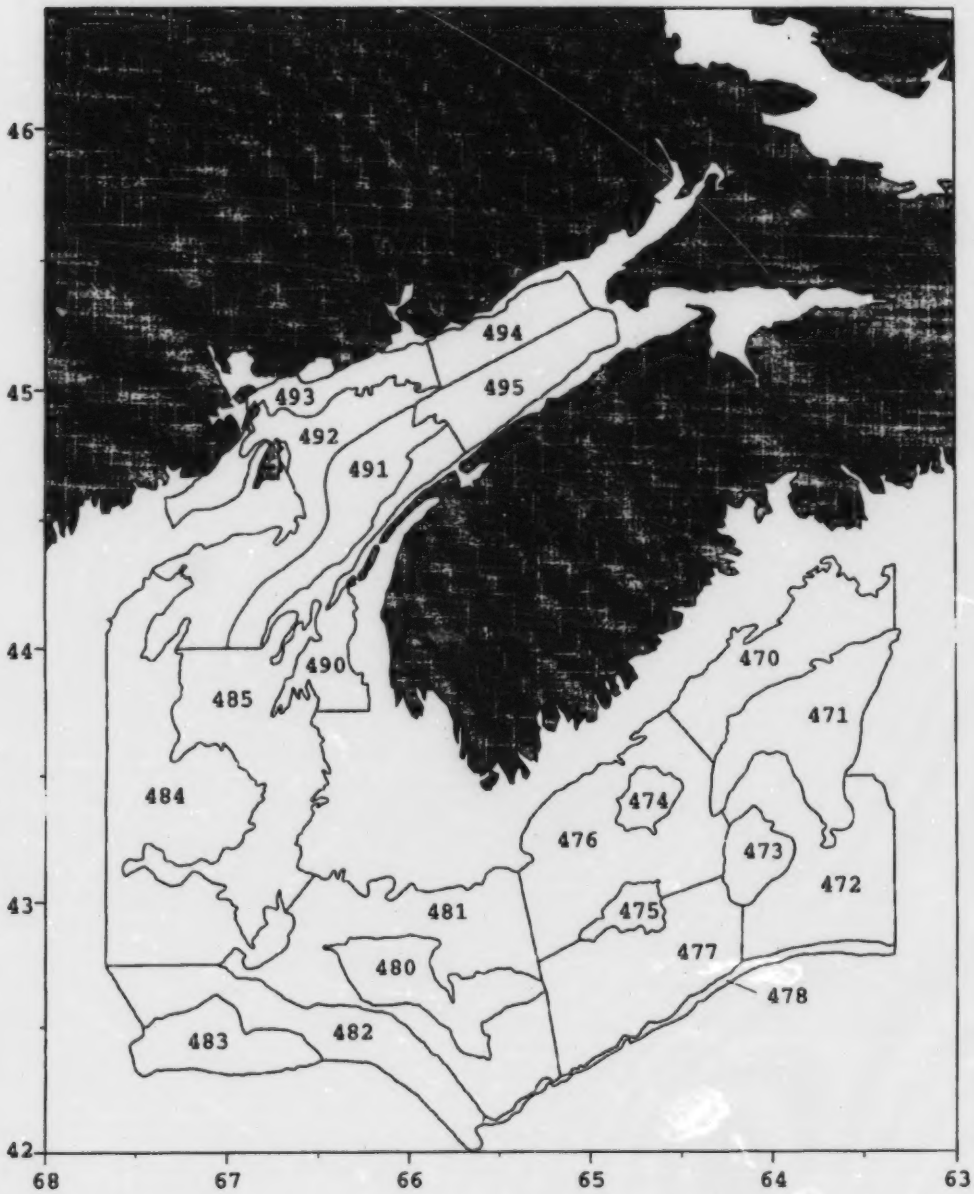


Figure 2. Research vessel survey strata in NAFO Division 4X.

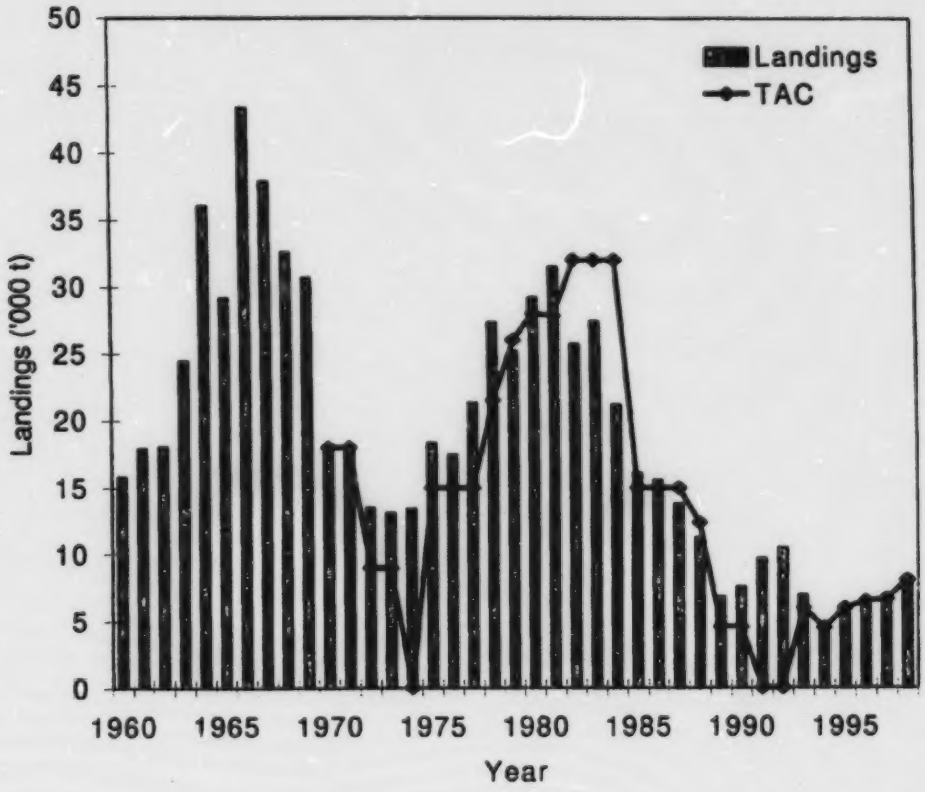


Figure 3. Long-term trends in 4X haddock landings, and TAC's. Canadian landings in 5Y are included.

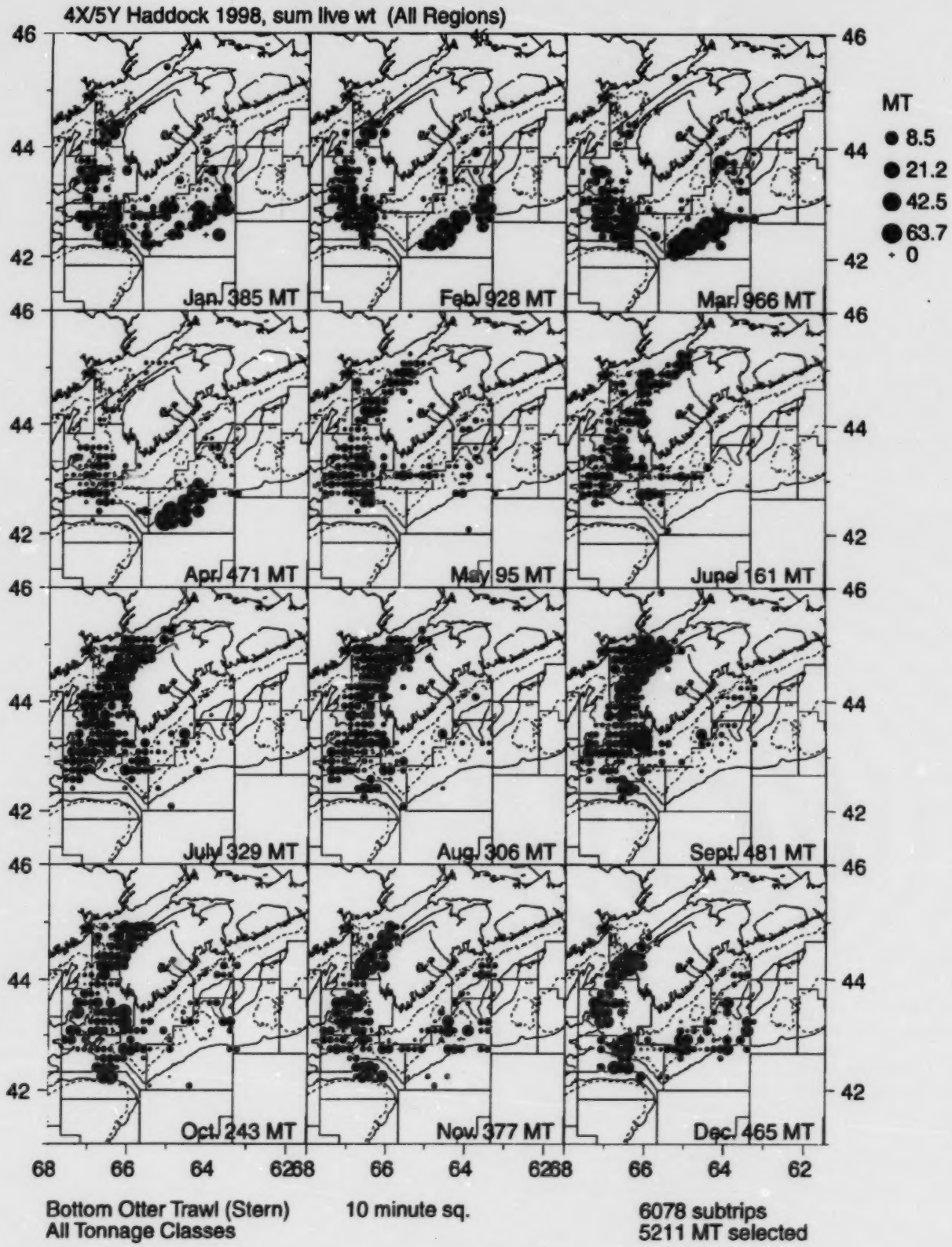


Figure 4a. Haddock catches by stern trawls in NAFO Divisions 4X+5Y by month in 1998, aggregated by 10x10 minute squares (where catch position was reported).

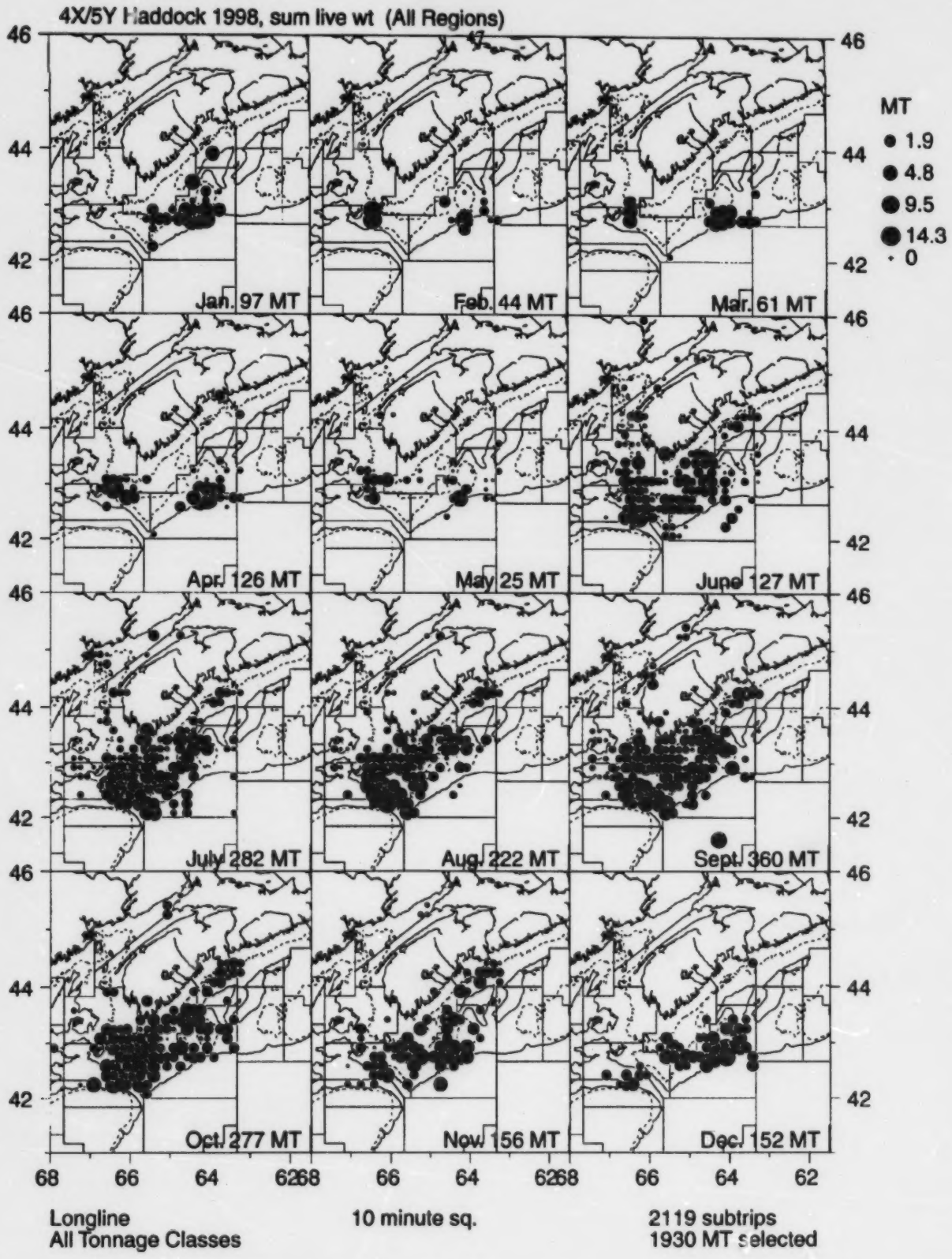


Figure 4b. Haddock catches by longlines in NAFO Divisions 4X+5Y by month in 1998, aggregated by 10x10 minute squares (where catch position was reported).

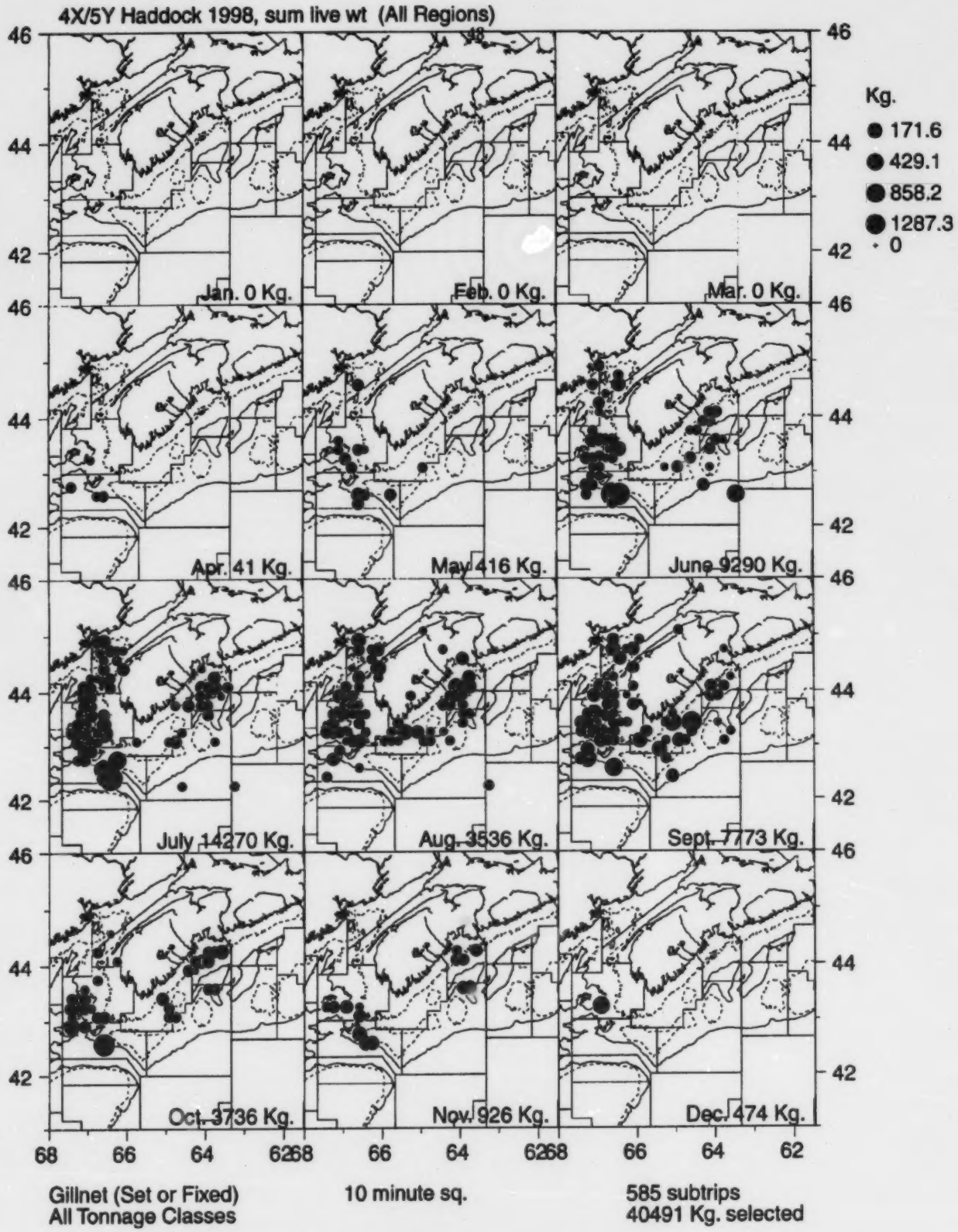


Figure 4c. Haddock catches by gillnets in NAFO Divisions 4X+5Y by month in 1998, aggregated by 10x10 minute squares (where catch position was reported).

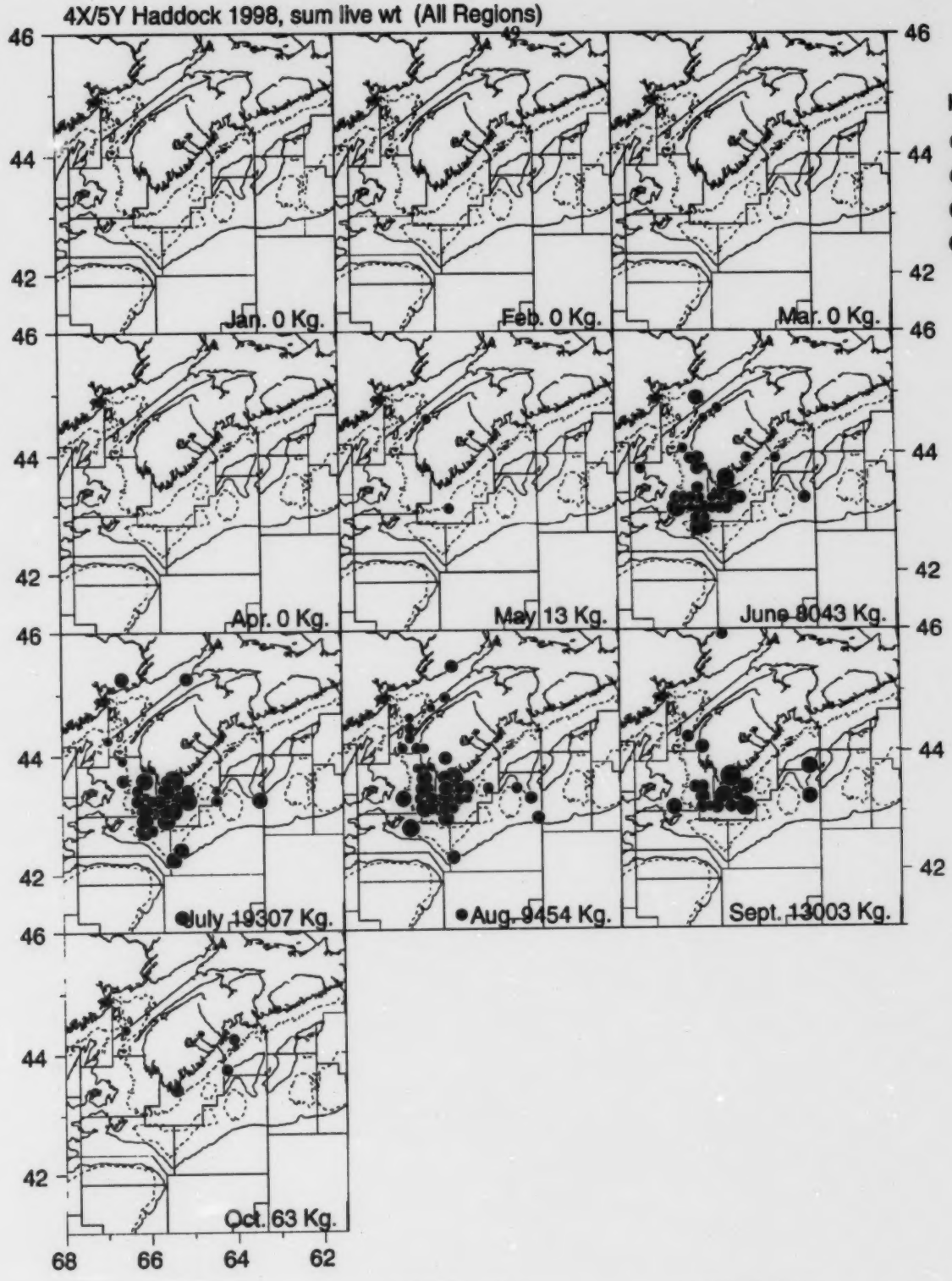


Figure 4d. Haddock catches by handlines in NAFO Divisions 4X+5Y by month in 1998, aggregated by 10x10 minute squares (where catch position was reported).

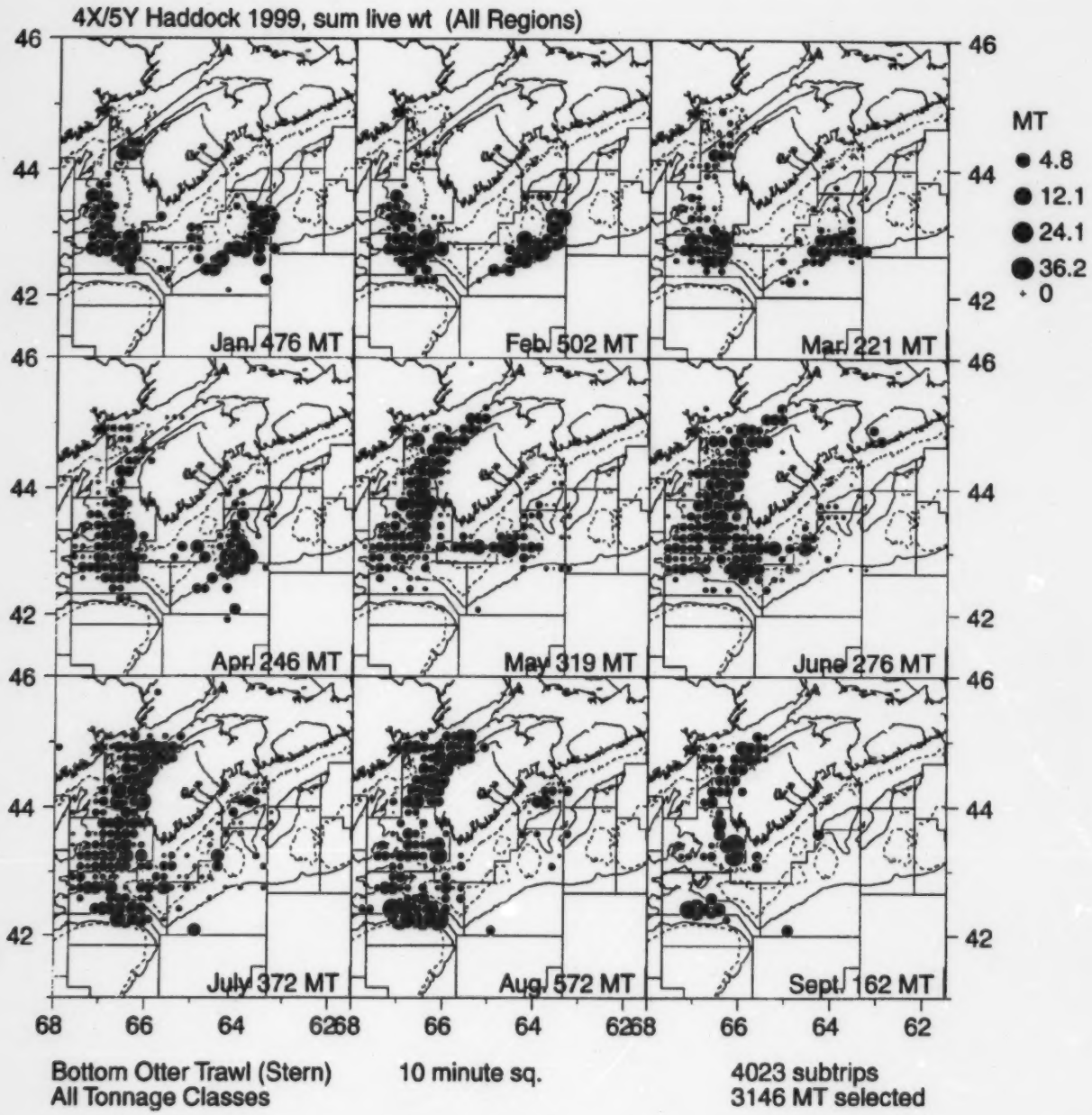


Figure 5a. Haddock catches by stern trawls in NAFO Divisions 4X+5Y by month in 1999 (to early September only), aggregated by 10x10 minute squares (where catch position was reported).

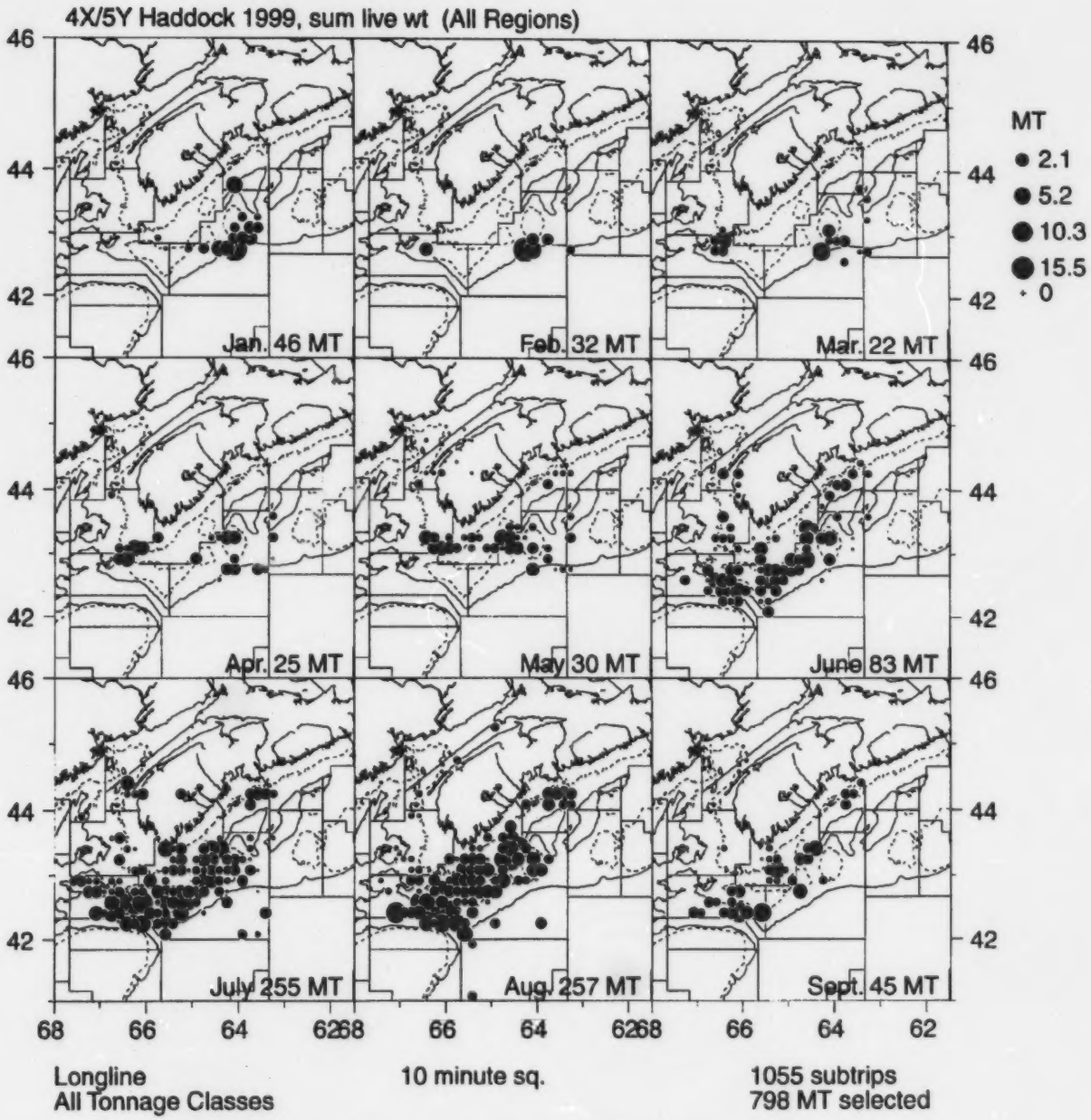


Figure 5b. Haddock catches by longlines in NAFO Divisions 4X+5Y by month in 1999 (to early September only), aggregated by 10x10 minute squares (where catch position was reported).

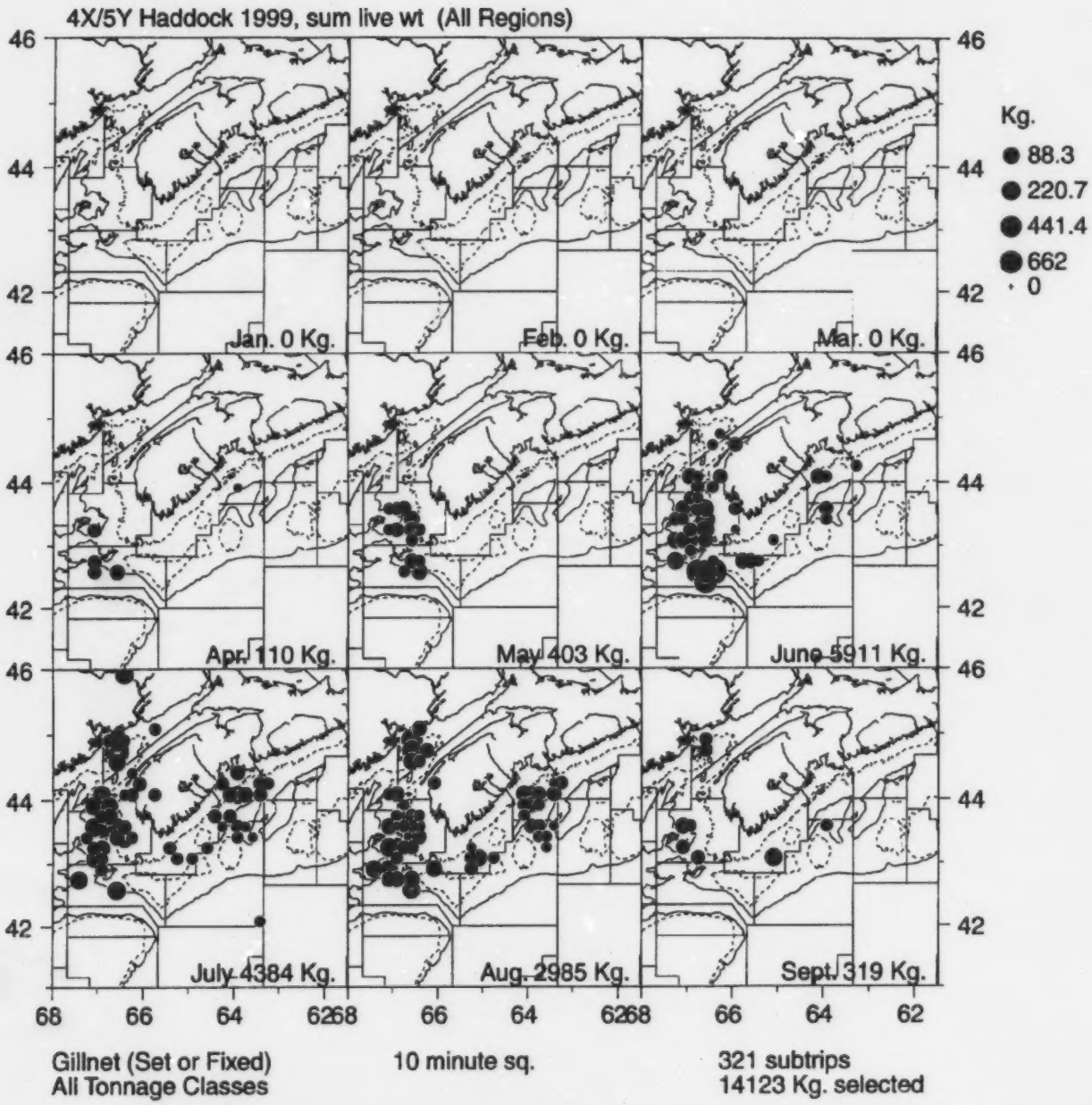


Figure 5c. Haddock catches by gillnets in NAFO Divisions 4X+5Y by month in 1999 (to early September only), aggregated by 10x10 minute squares (where catch position was reported).

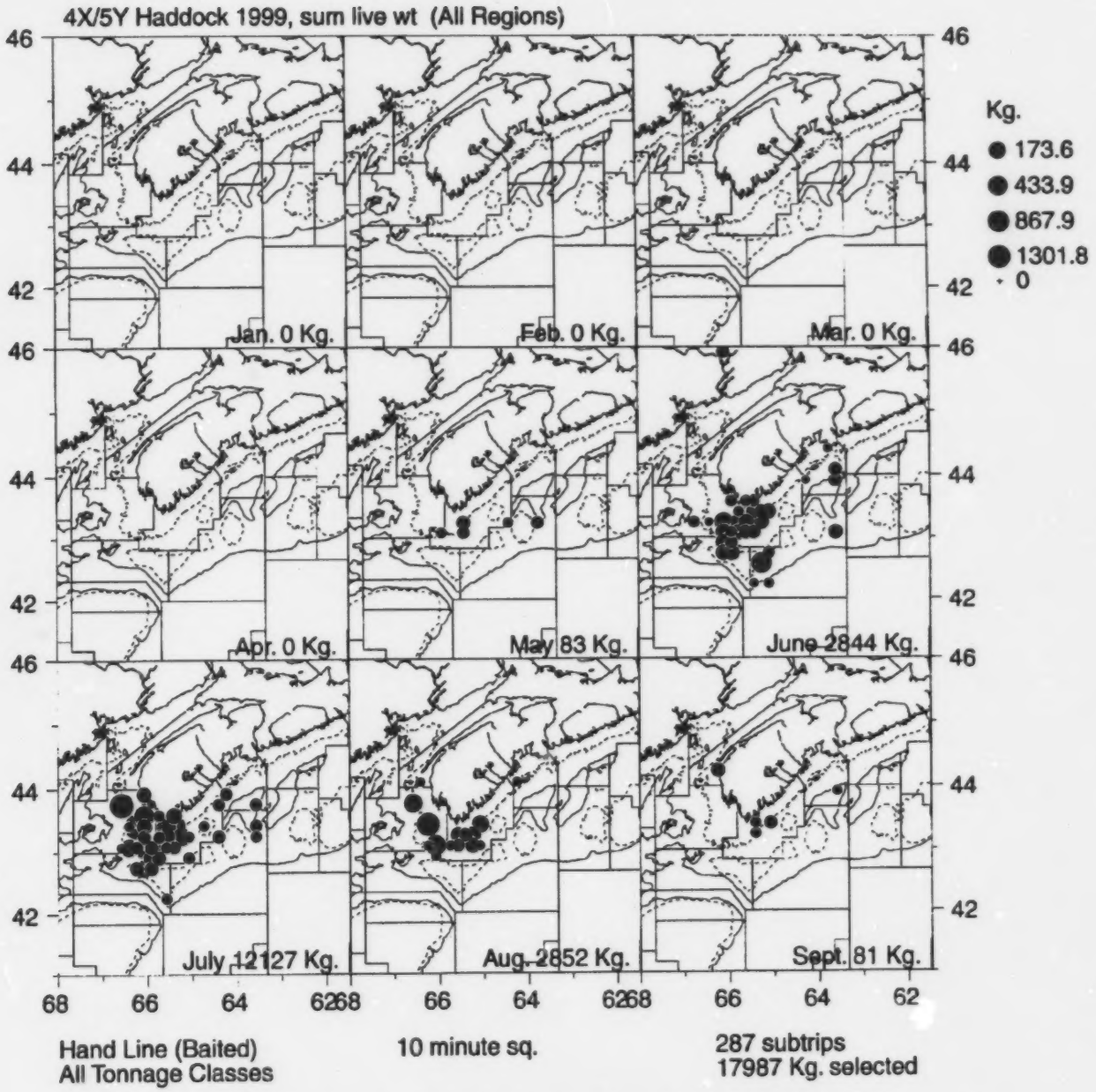


Figure 5d. Haddock catches by handlines in NAFO Divisions 4X+5Y by month in 1999 (to early September only), aggregated by 10x10 minute squares (where catch position was reported).

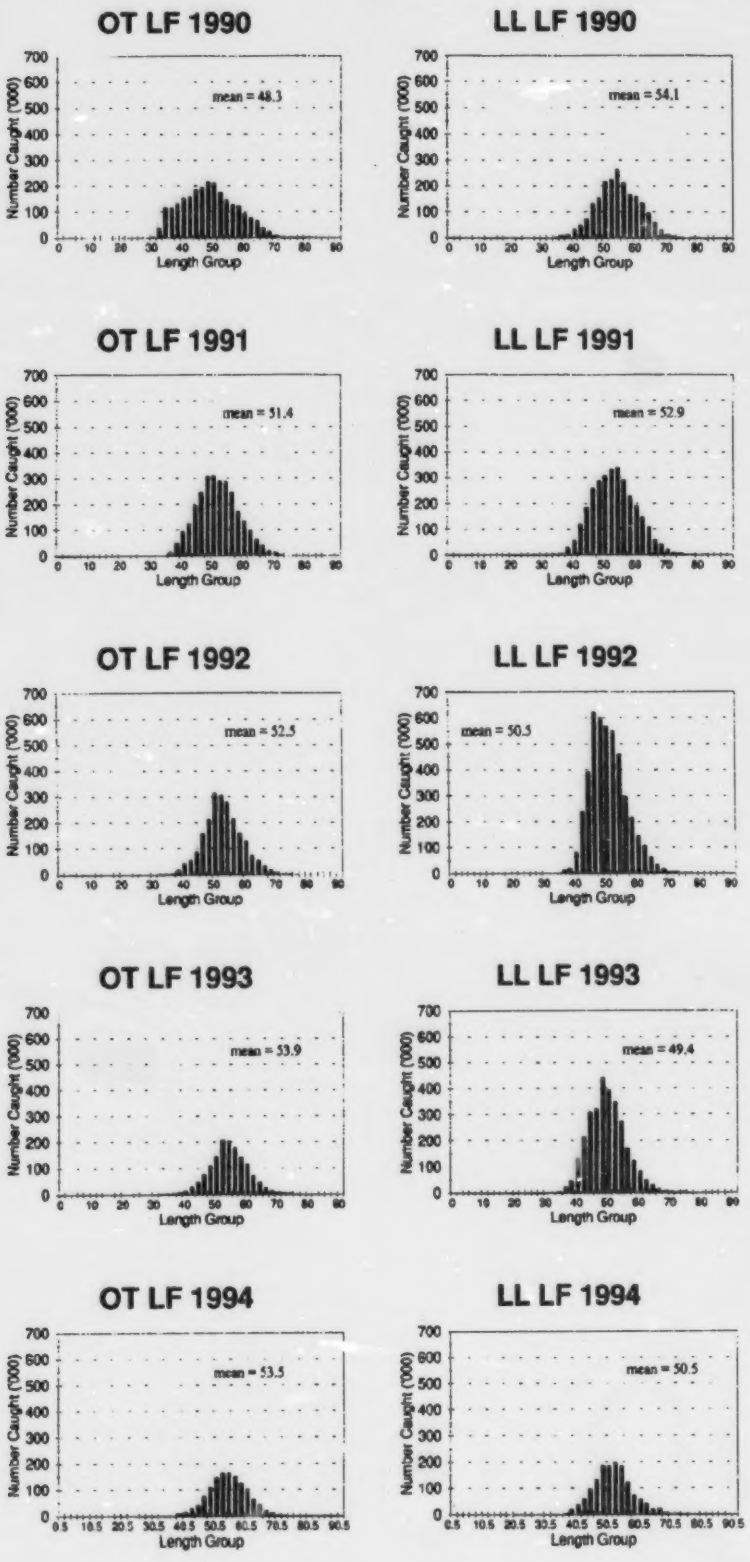


Figure 6a. Catch-at-length (cm) for 4X haddock, 1990-1993, for the otter trawl and longline gear sectors.

lf_gear.wb1

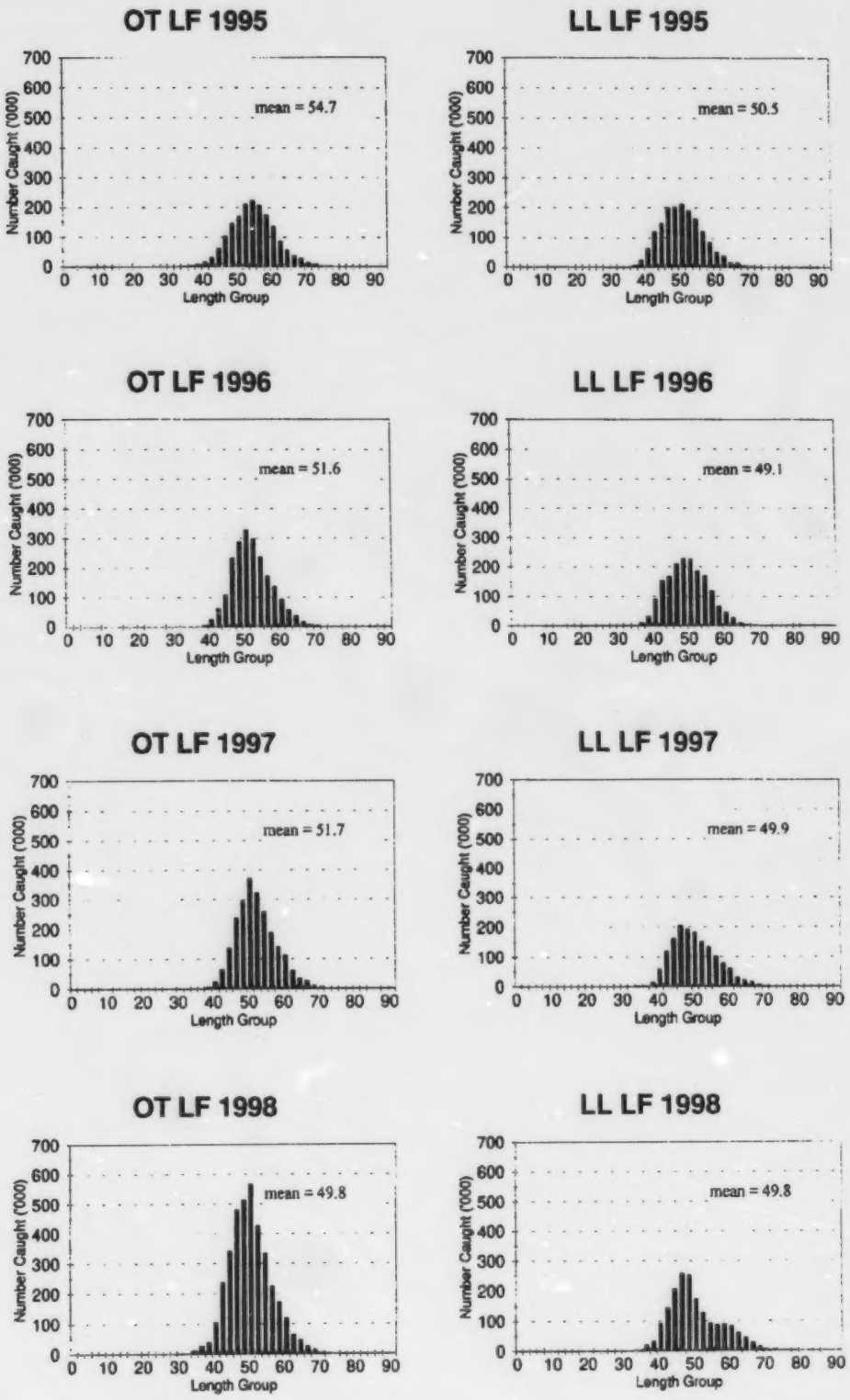
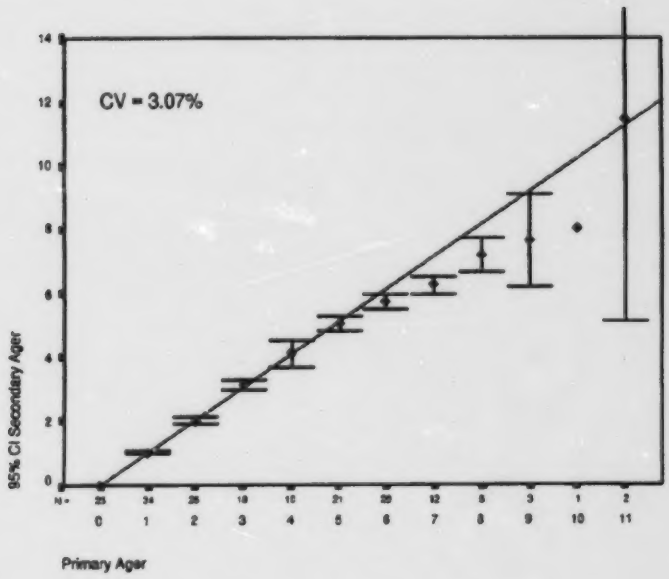


Figure 6b. Catch-at-length (cm) for 4X haddock, 1995-1998, for the otter trawl and longline gear sectors.

ll_gear.wb1

A.



B.

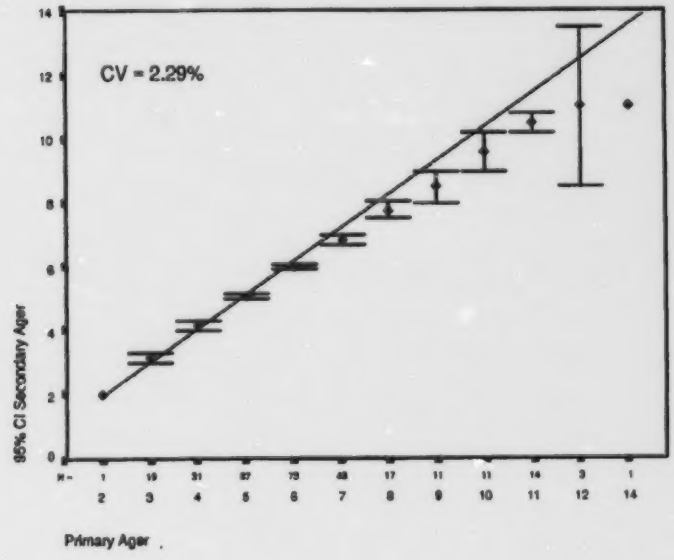


Figure 7. Age bias plots of pairwise age comparisons of 4X haddock ageing for (A) the 1999 Research Vessel Survey and (B) commercial samples from July 1998 – June 1999. Bars represent 95% confidence interval around each category. The line represents the 1:1 line. Sample size is indicated above the x-axis labels.

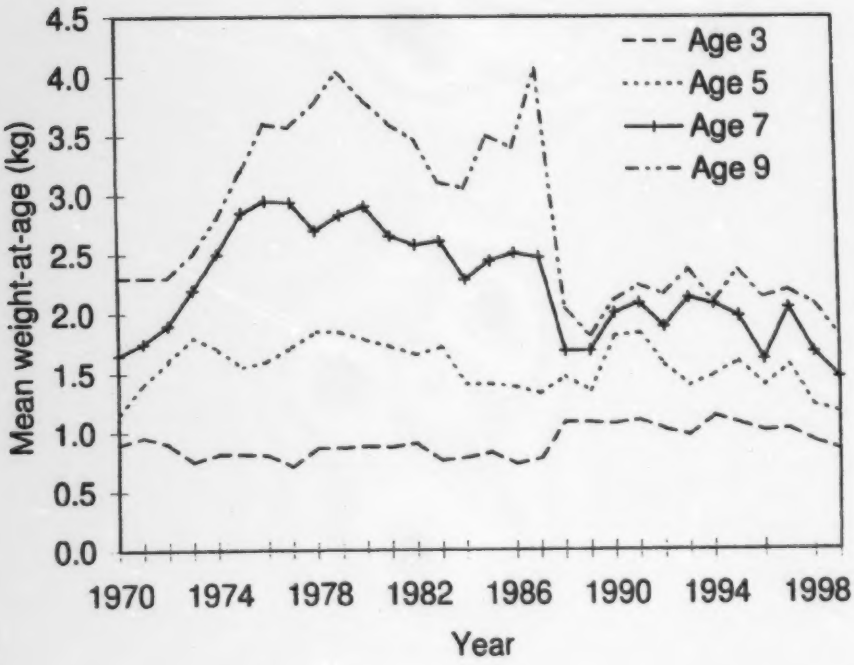


Figure 8. 4X haddock commercial mean weight-at-age.

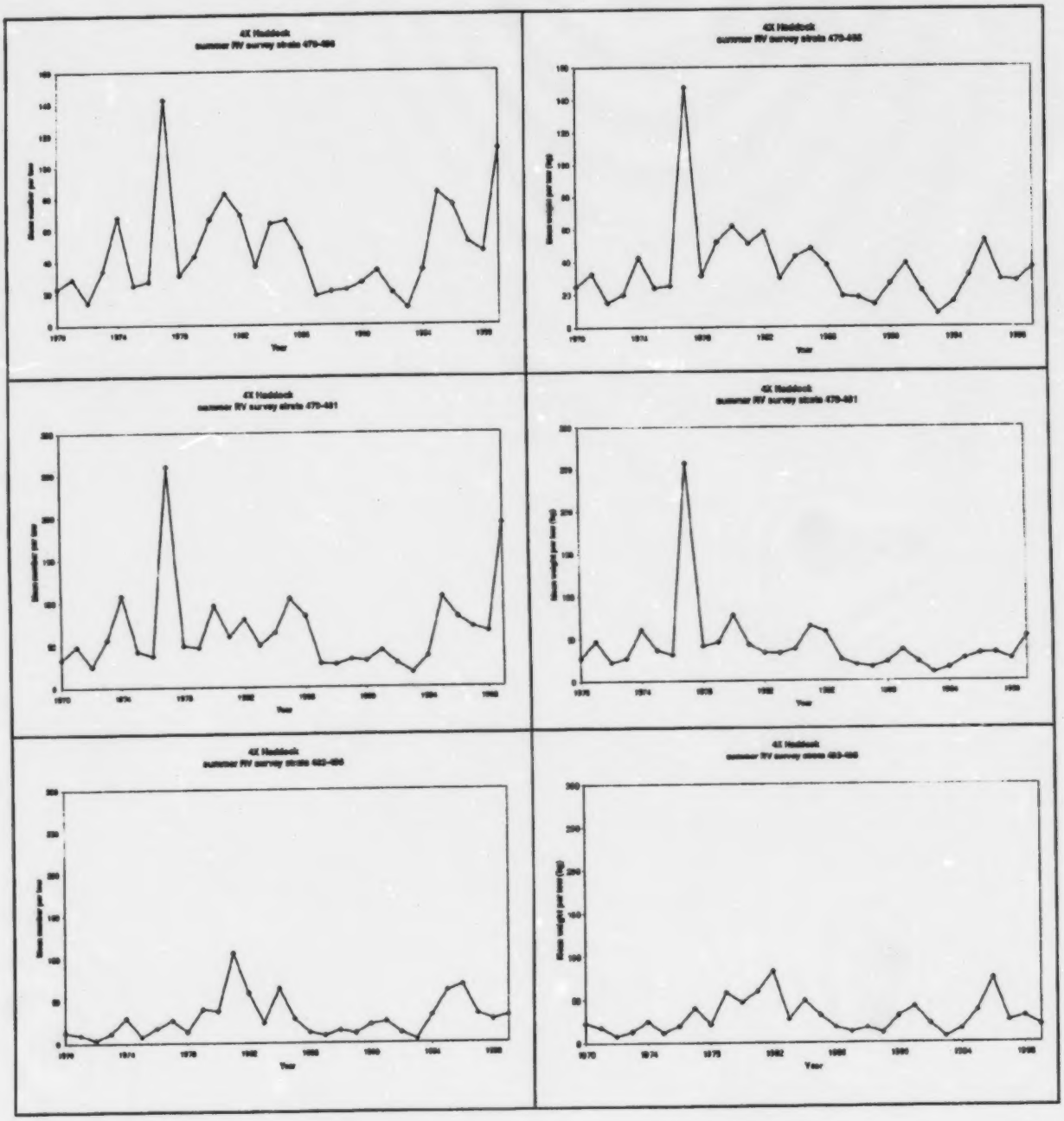


Figure 9. 4X haddock mean number and weight-per-tow from the summer research vessel survey.

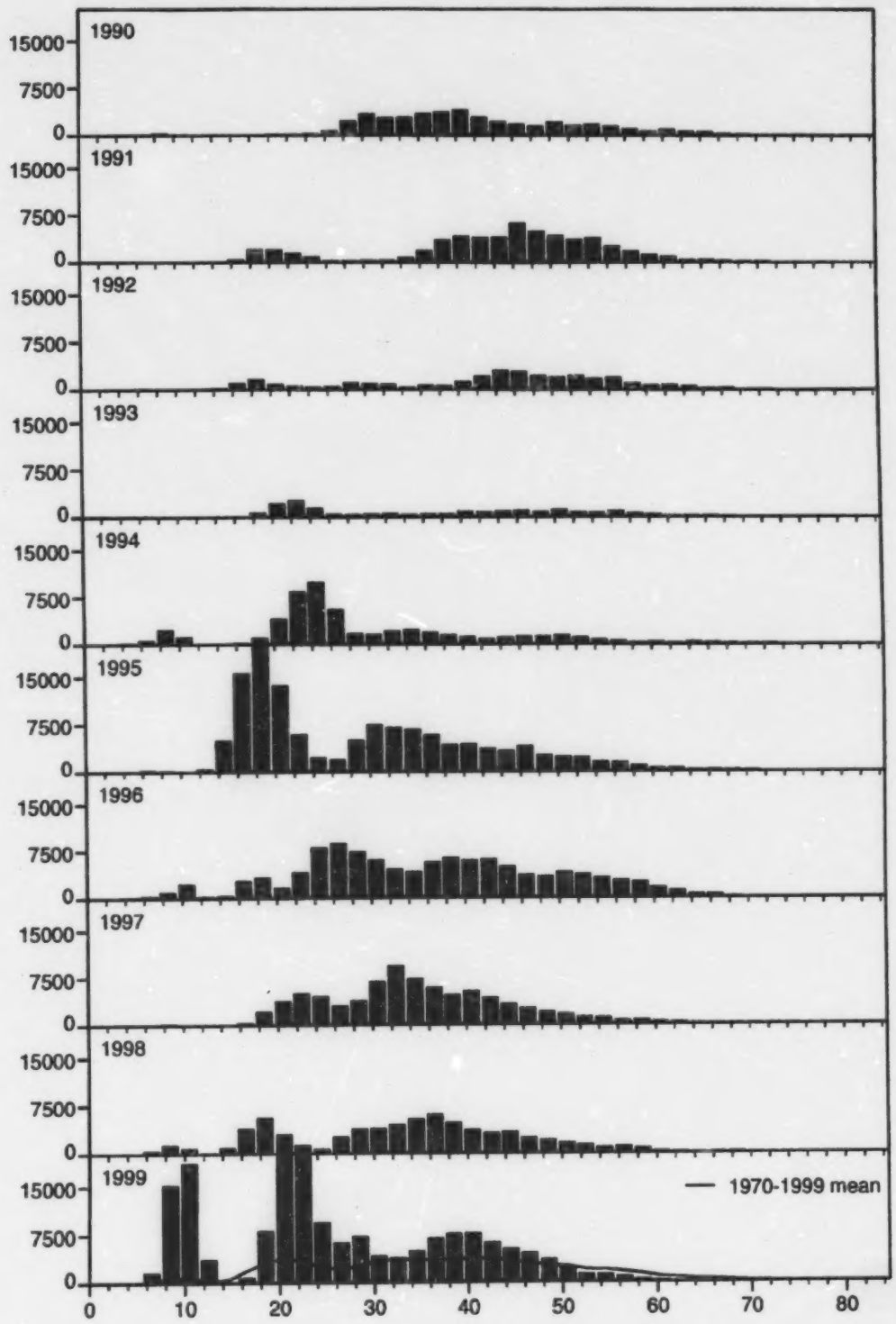


Figure 10. 4X haddock mean number per tow at length from the summer research vessel survey for strata 470-495, 1990-99.

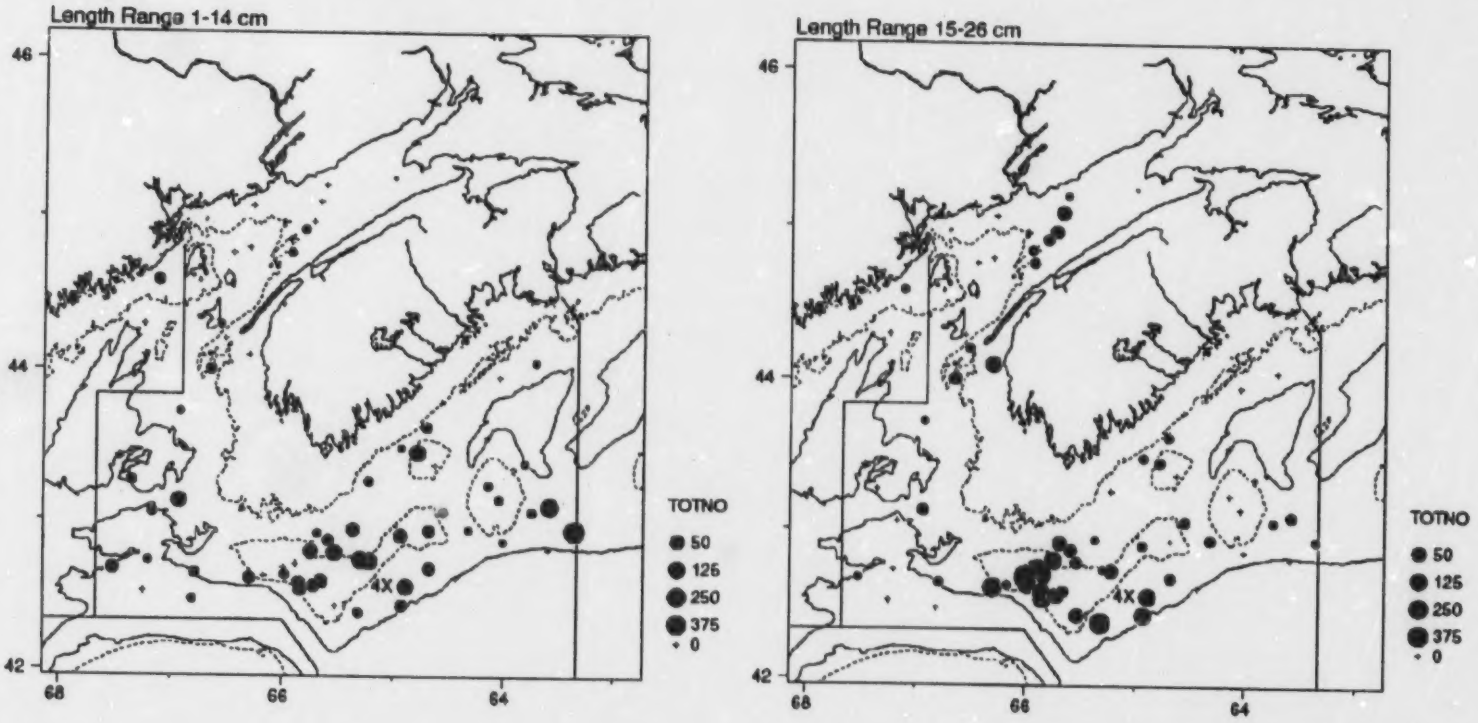


Figure 11. 4X haddock number per tow in the 1999 summer research vessel survey in the length range 1-14cm (age 0) and 15-26cm (age 1).

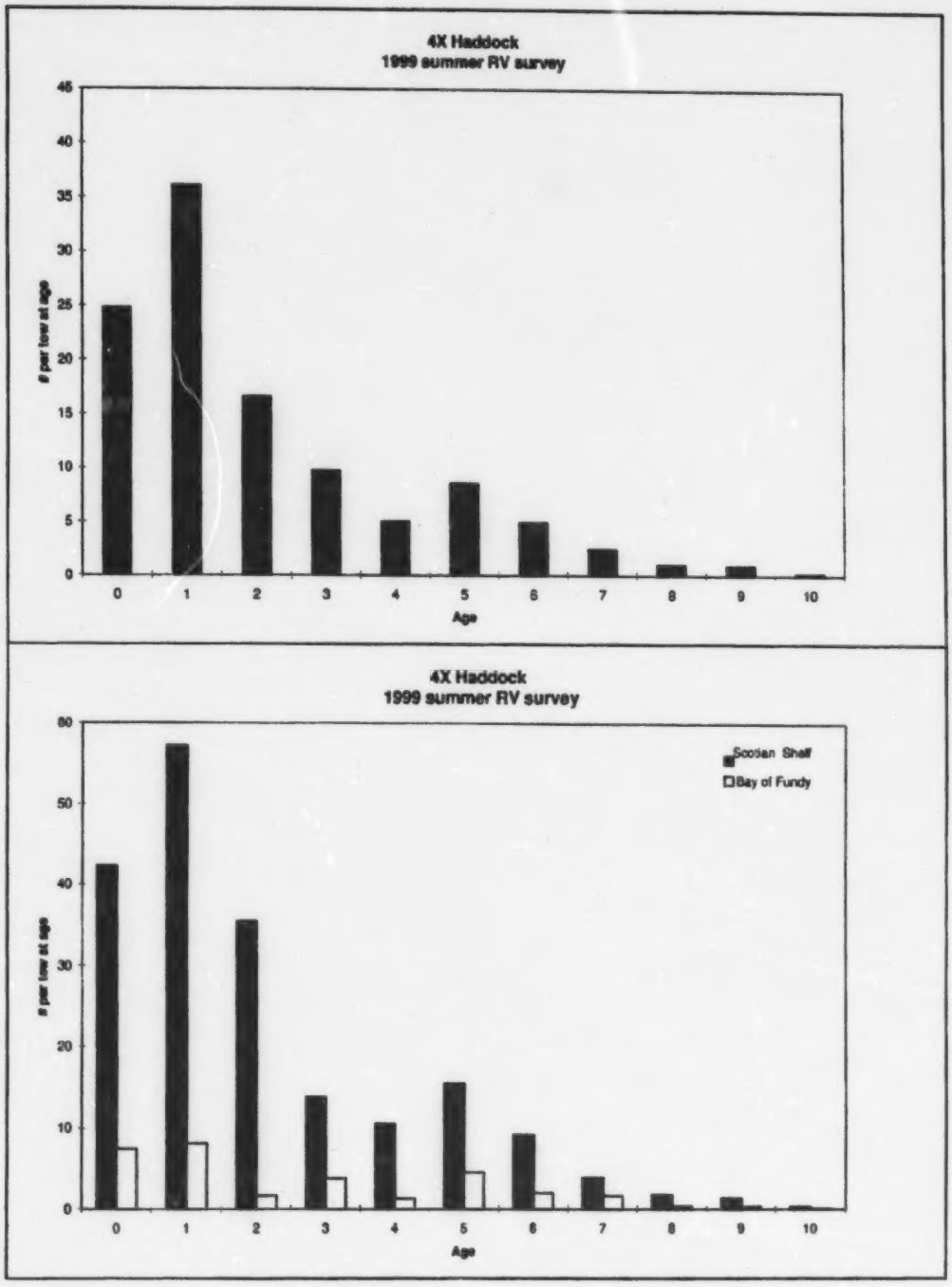


Figure 12. 4X haddock mean number-per-tow at age for all survey strata and for the Scotian Shelf and Bay of Fundy strata from the summer research vessel survey.

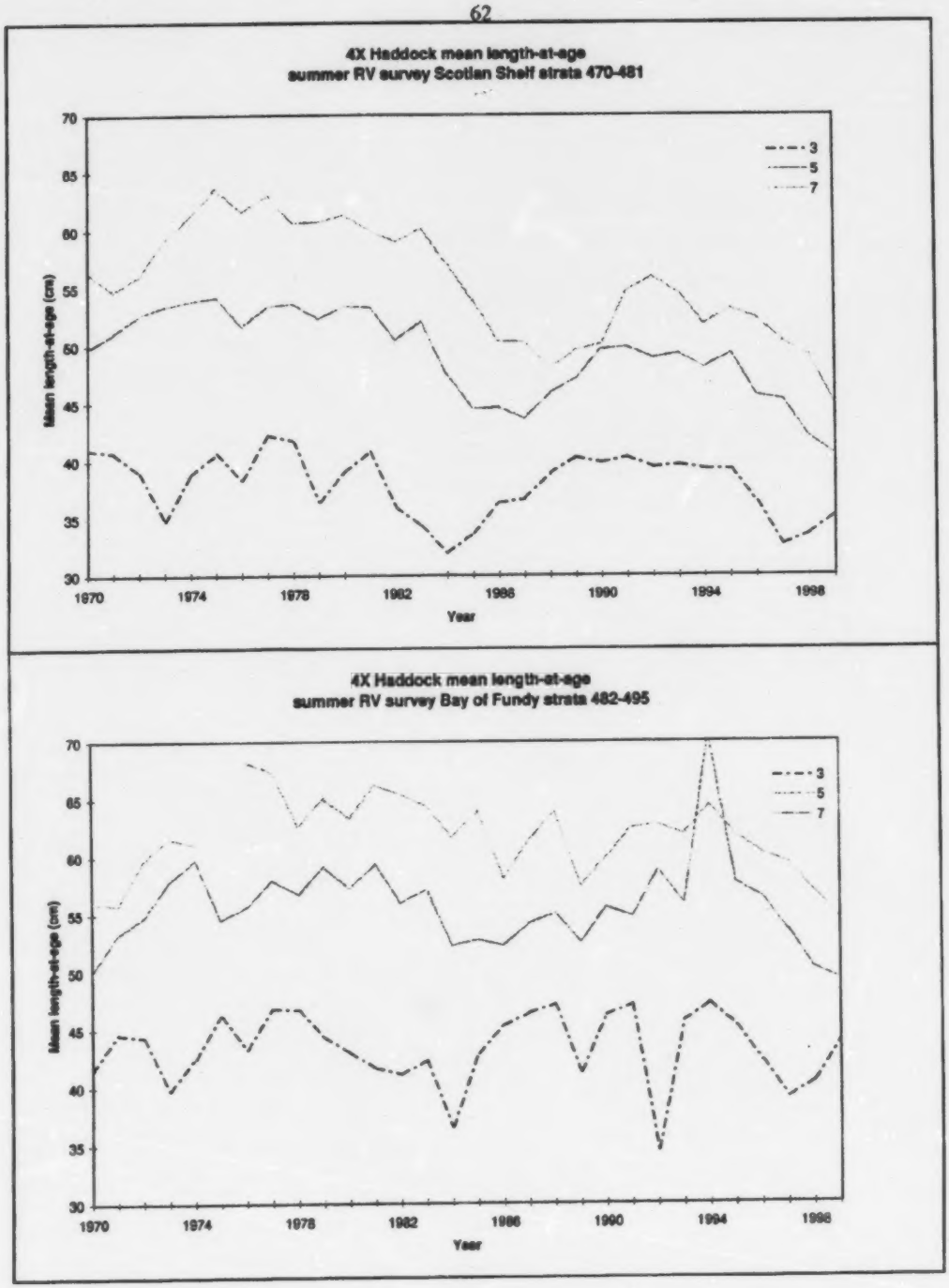


Figure 13. 4X haddock mean length-at-age for the Scotian Shelf and Bay of Fundy strata from the summer research vessel survey.

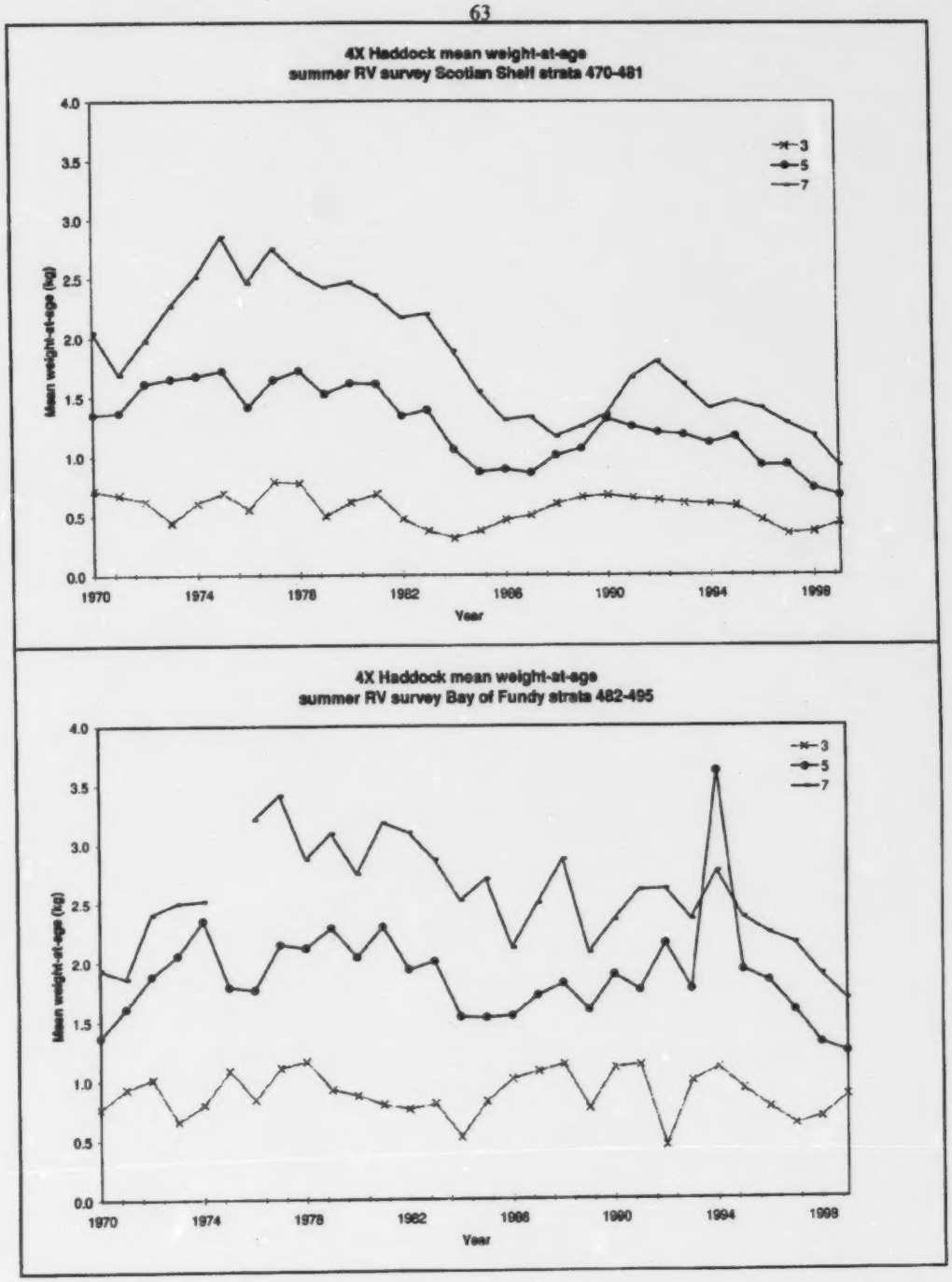


Figure 14. 4X haddock mean weight-at-age for the Scotian Shelf and Bay of Fundy strata from the summer research vessel survey.

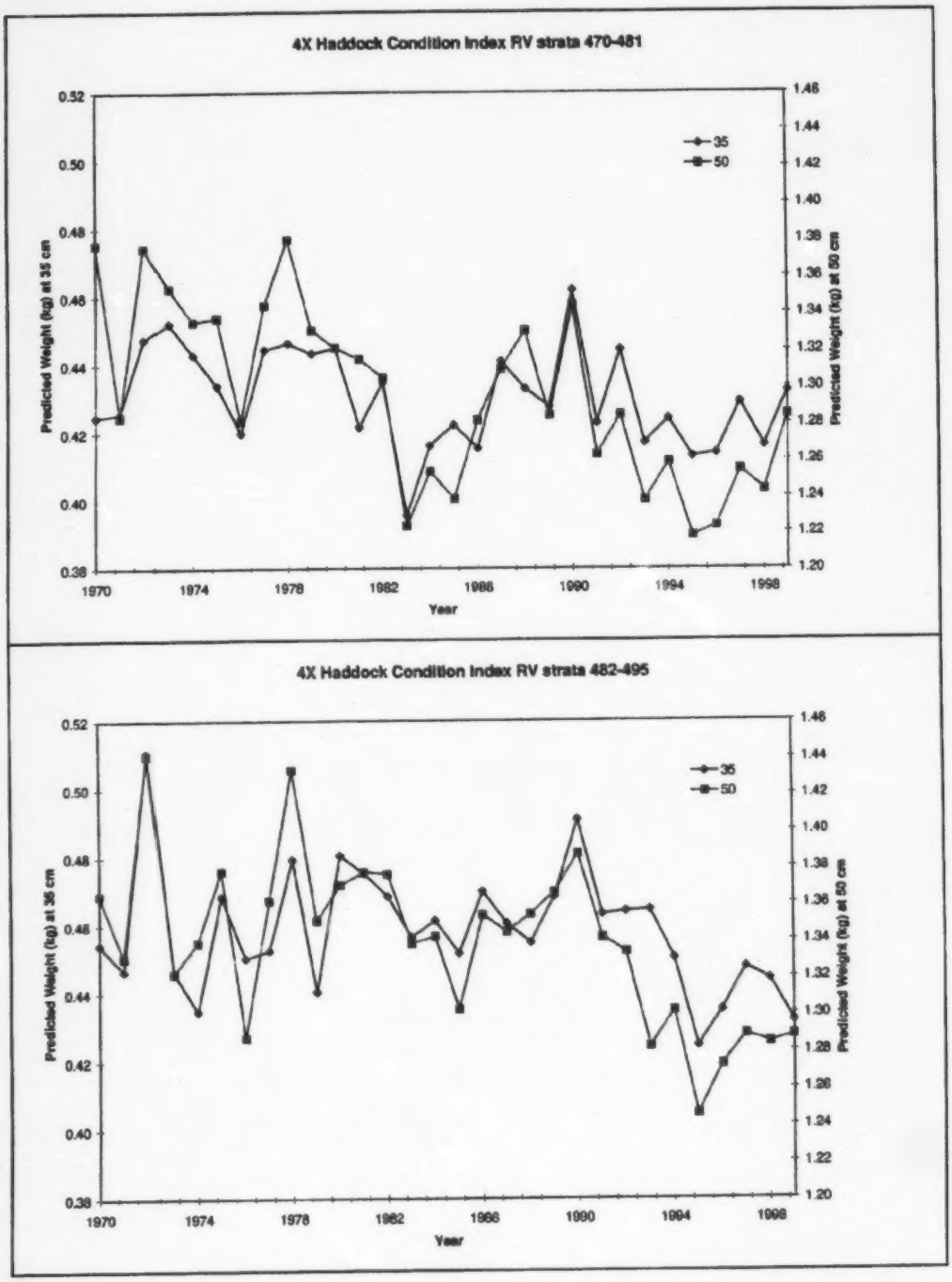


Figure 15. Predicted weight at length for 35 and 50cm 4X haddock from the Scotian Shelf and Bay of Fundy summer research vessel survey, predicted using research vessel length-weight relationships.

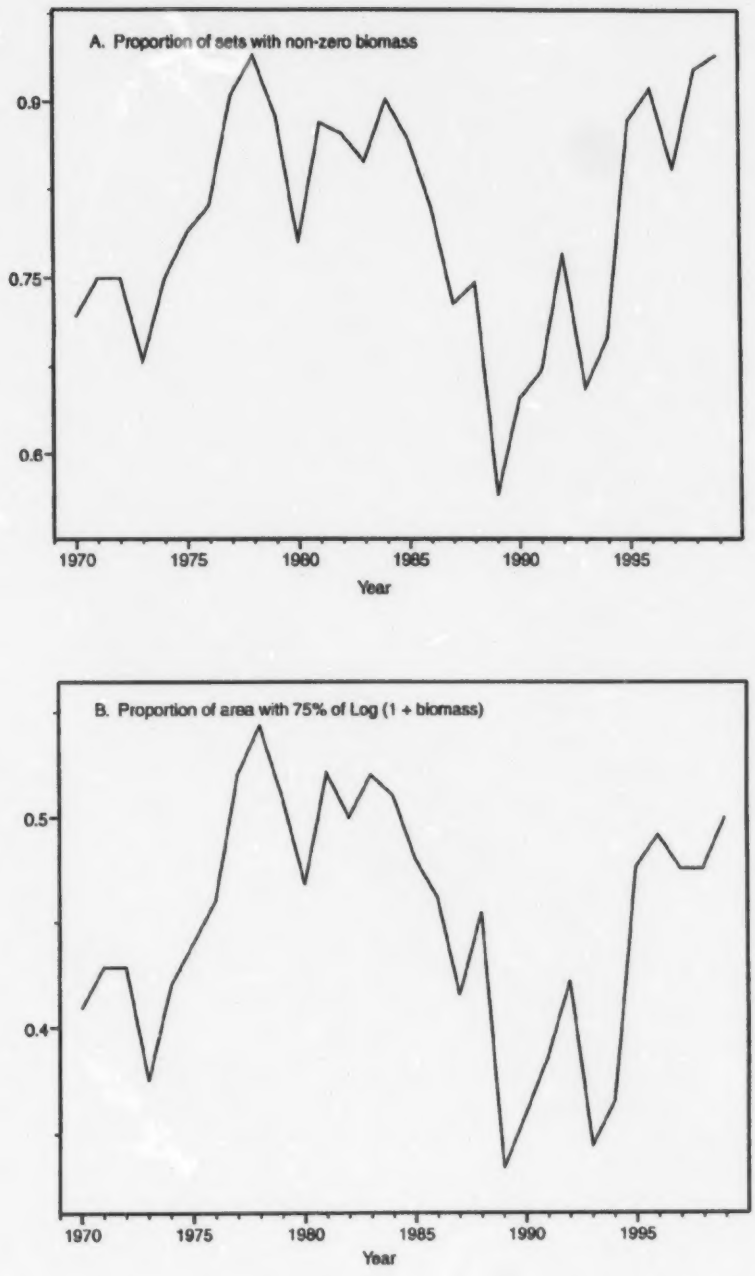


Figure 16. Indices of (A) geographical range and (B) resource concentration for 4X haddock from the summer research vessel survey (strata 470-495).

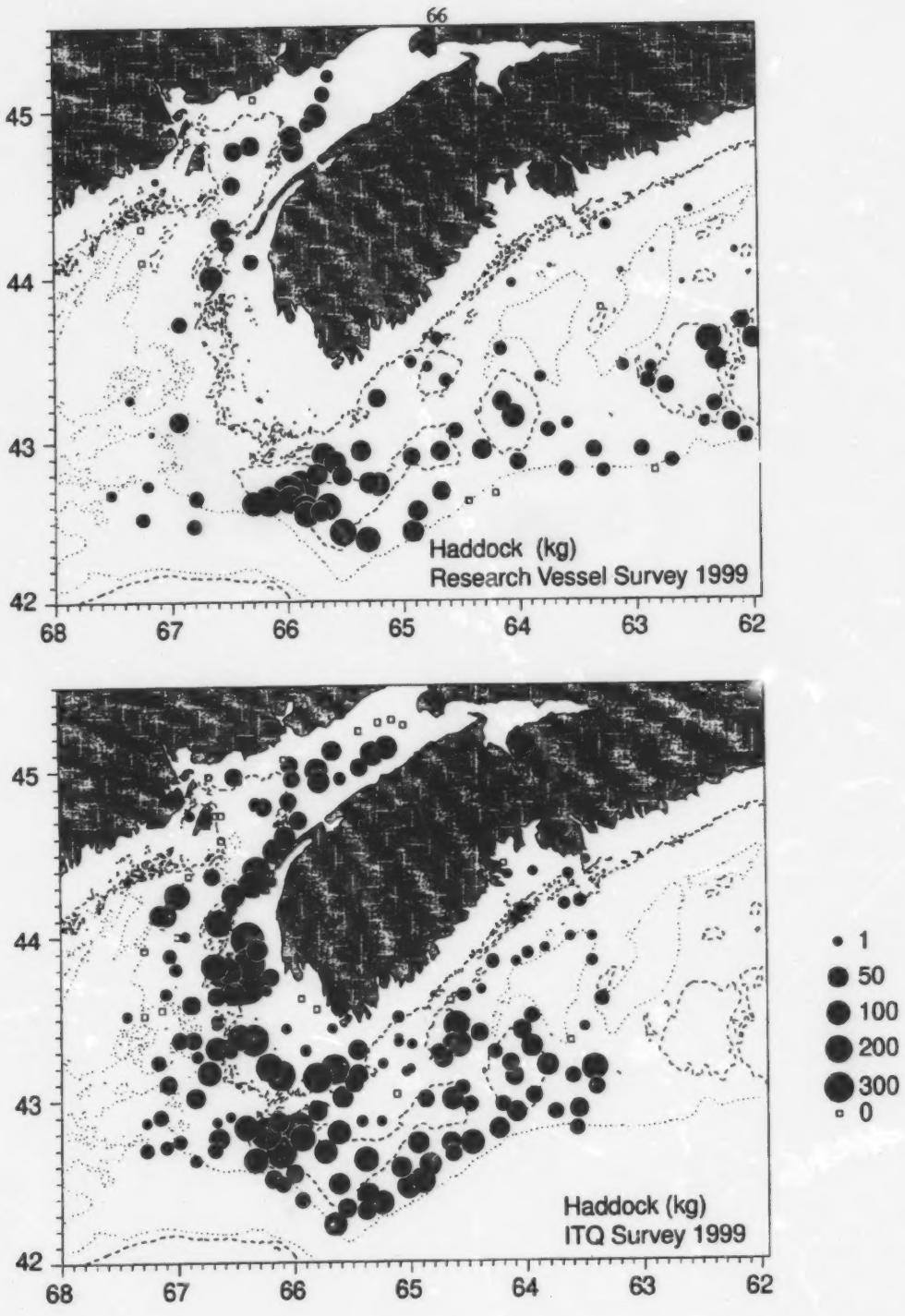


Figure 17. 4X haddock catches (kg) per standard tow from the 1999 summer research vessel and ITQ surveys.

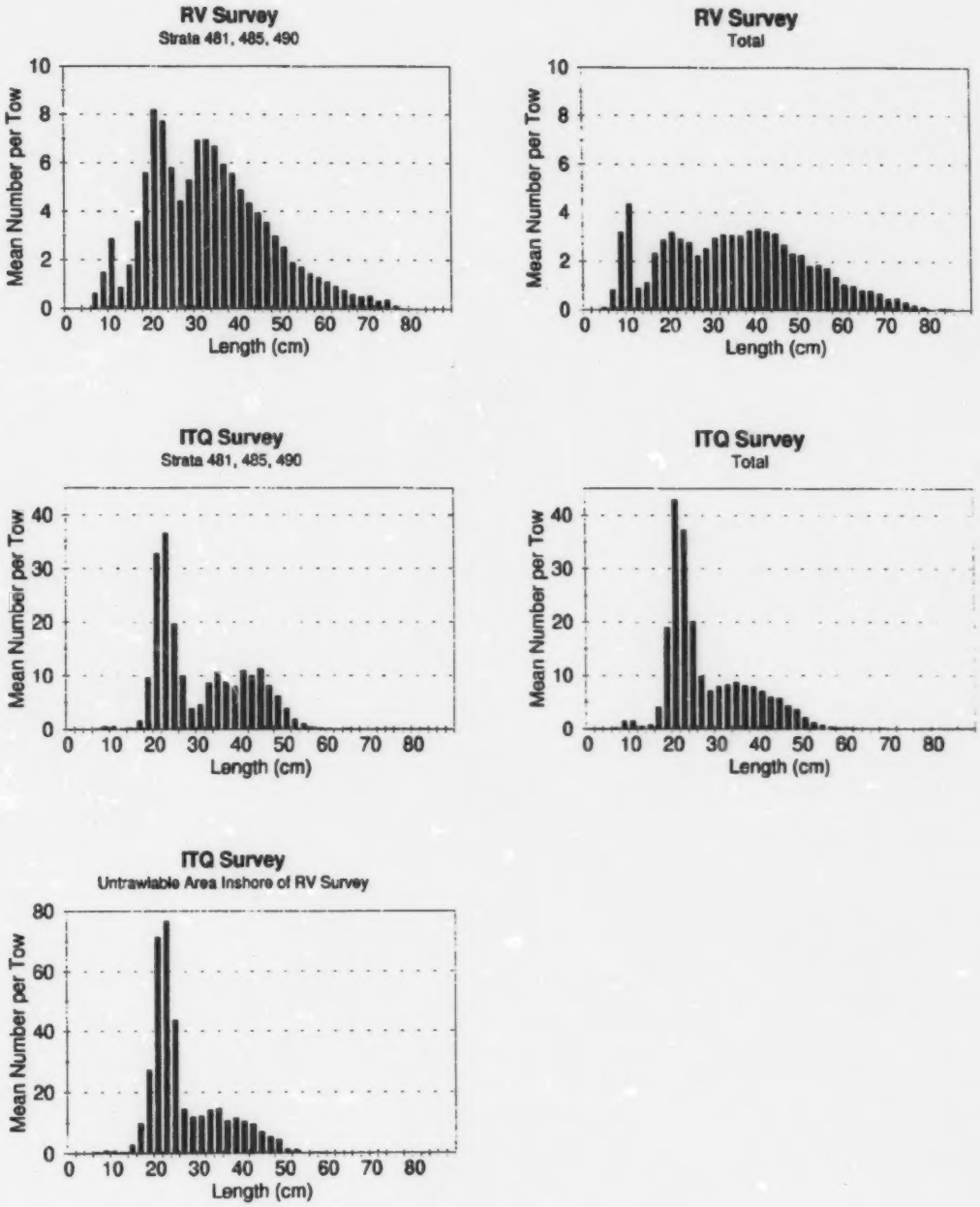


Figure 18. 4X haddock length frequency distributions from the 1999 summer research vessel and ITQ surveys, for the total survey area, for strata 481, 485, and 490, and for the area inshore of the research vessel survey strata.

fig99.wb1

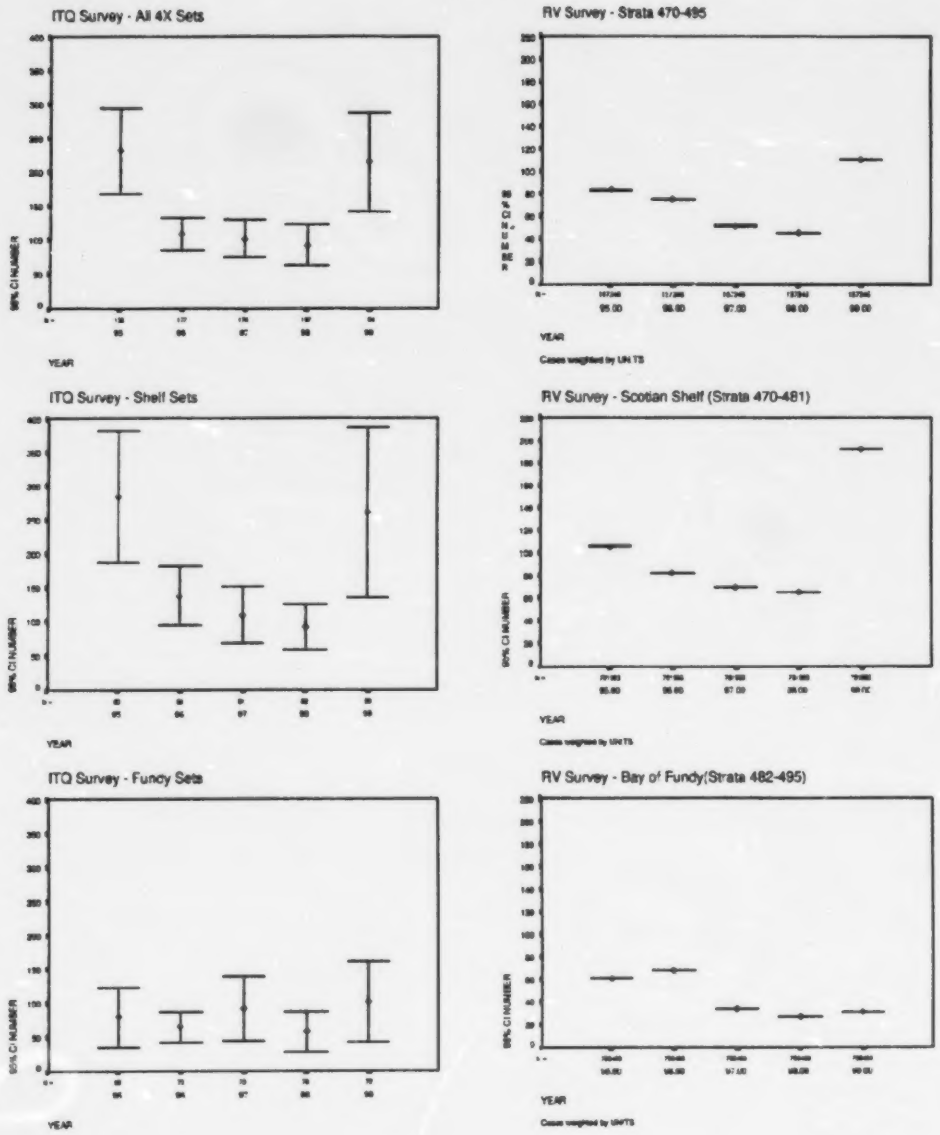

ITQ Survey - All 4X Sets
RV Survey - Strata 470-495
ITQ Survey - Shelf Sets
RV Survey - Scotian Shelf (Strata 470-481)
ITQ Survey - Fundy Sets
RV Survey - Bay of Fundy(Strata 482-495)
YEAR

Figure 19. 4X haddock mean catch rates (#/tow), from the ITQ surveys on the left and the research vessel surveys on the right, 1995-1999 for: all survey strata; Scotian Shelf strata; and Bay of Fundy strata.

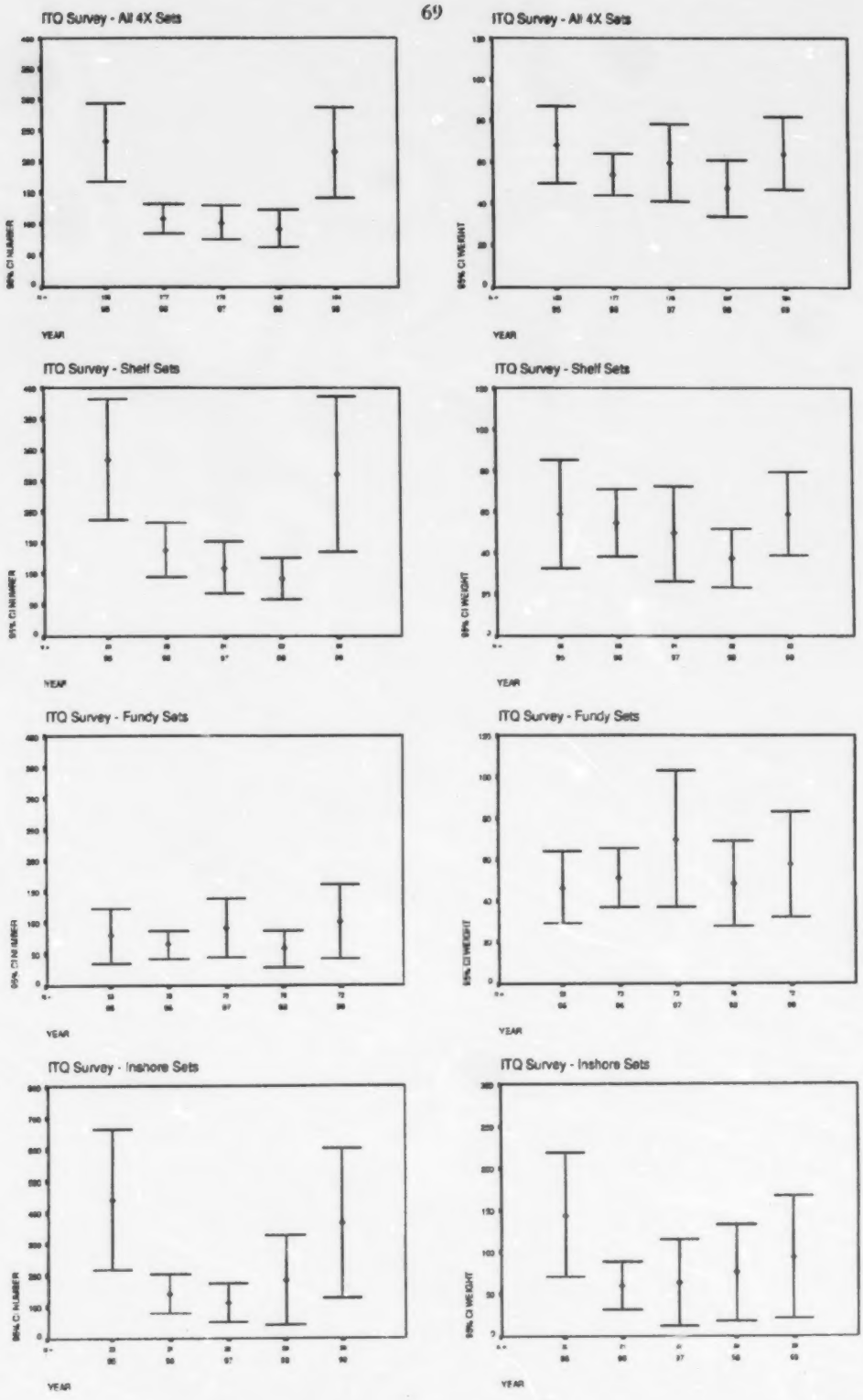
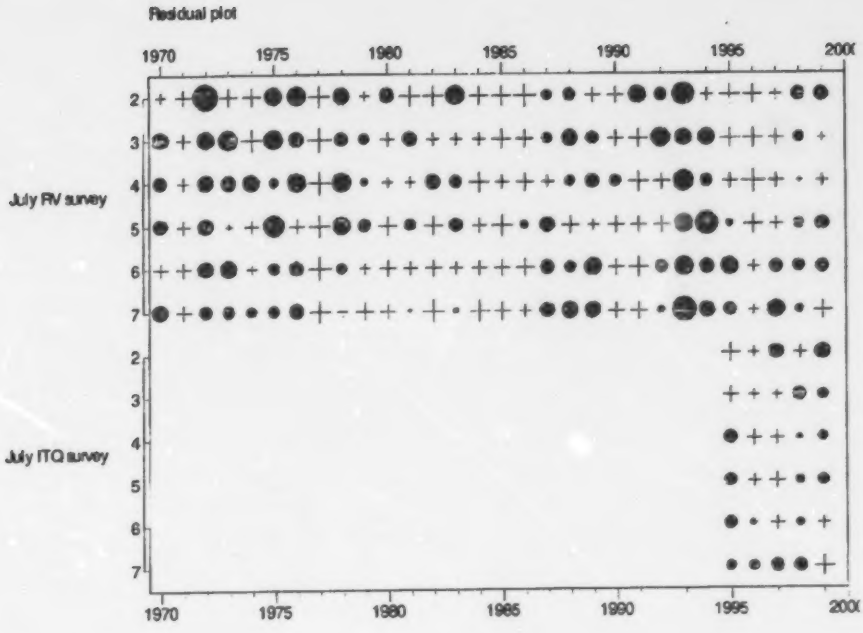


Figure 20. 4X haddock mean catch rates, #/tow on left and kg/tow on right for all sets, for Scotian Shelf strata, for Bay of Fundy strata, and for the area inshore of the research vessel survey strata from the ITQ surveys, 1995-1999.



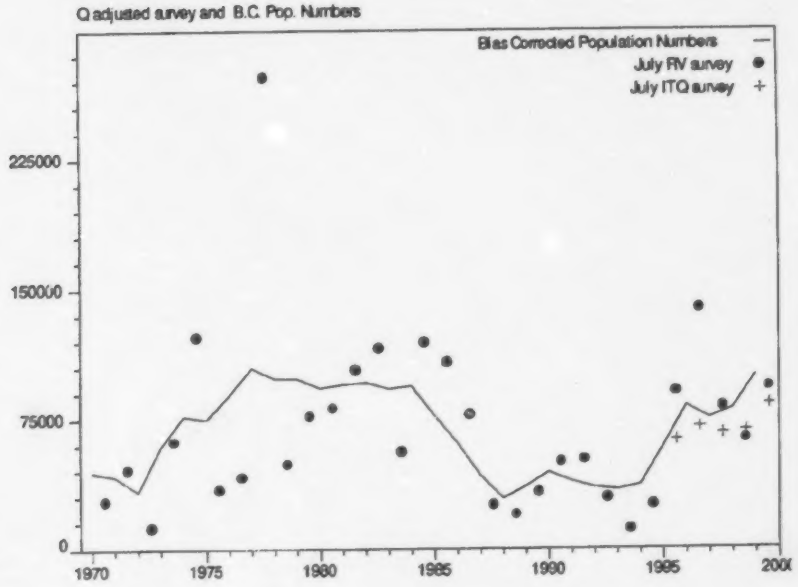


Figure 21. Residuals at age, and Population numbers(ages 2-7) estimated from the model and the q-adjusted survey indices.

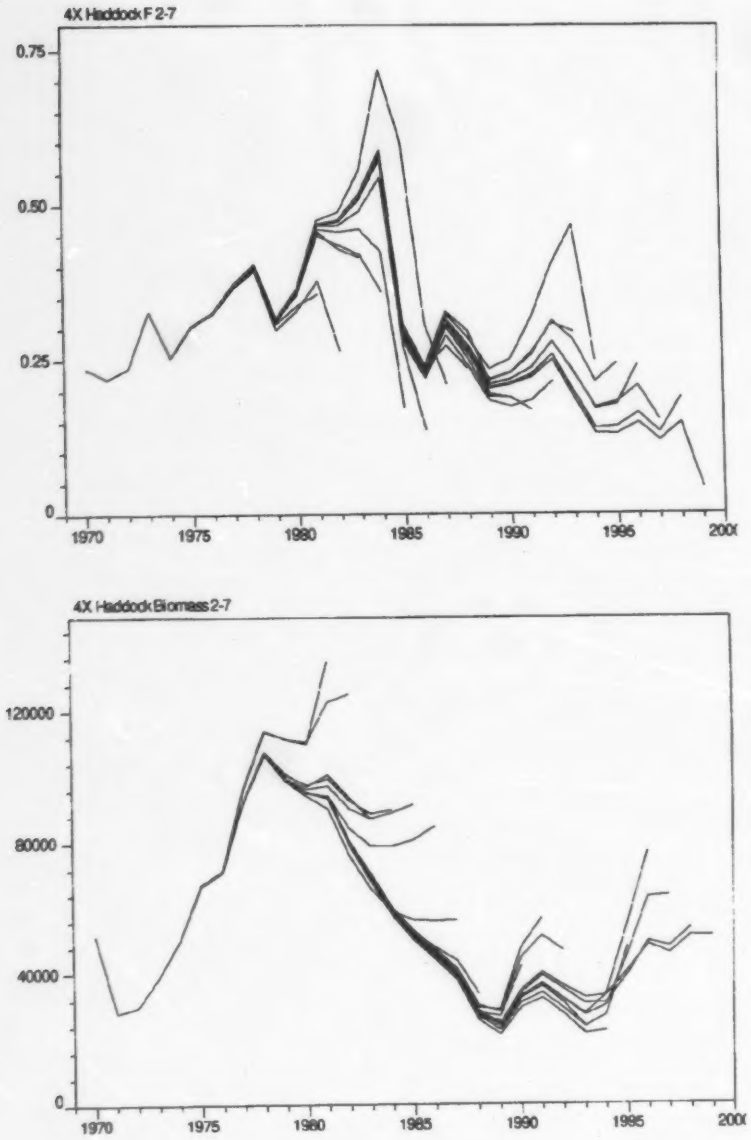


Figure 22. Retrospective analysis of SPA results.

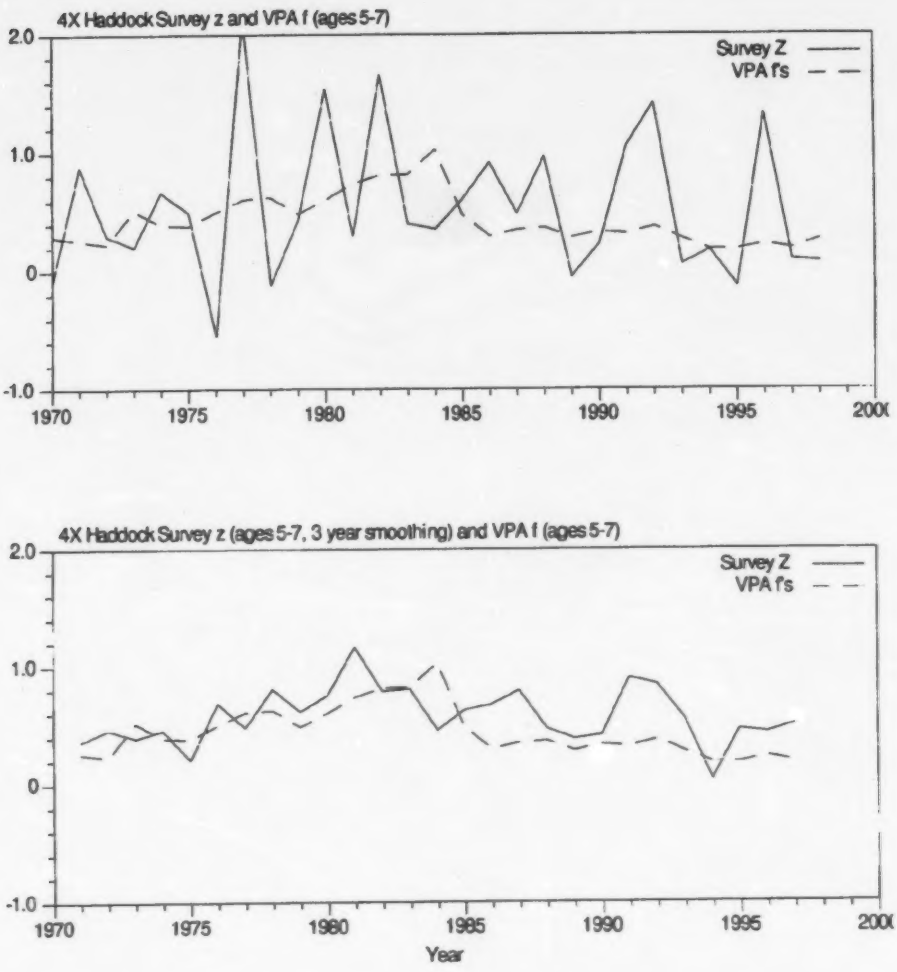


Figure 23. Comparison of total mortalities(Z) calculated from the summer research vessel survey and fishing mortalities from the SPA for fully recuirted ages (5-7). Three year running means in the lower panel.

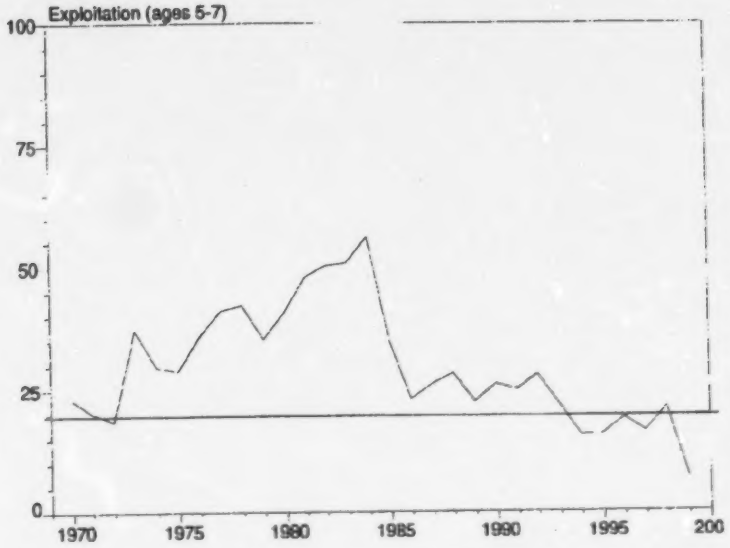


Figure 24. Exploitation level (%) for 4X Haddock 19970-1999 from this assessment (note 1999 value is from half-year landings).

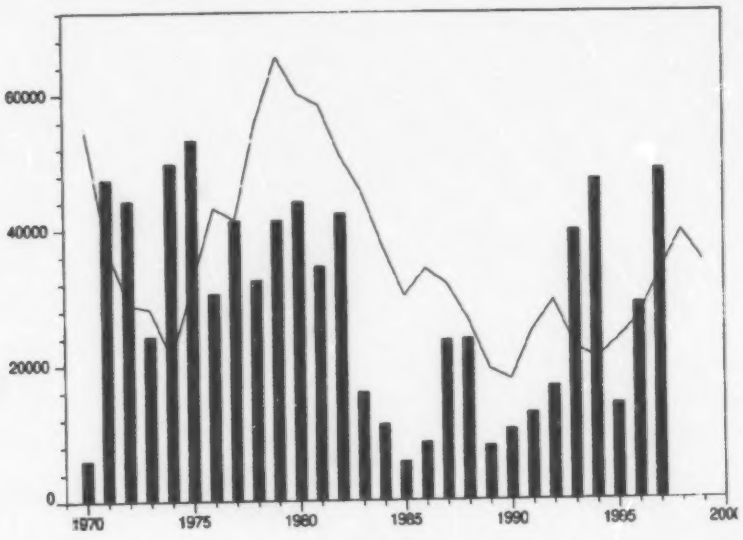


Figure 25. Spawning stock biomass and age 1 recruitment in the subsequent year from this assessment.

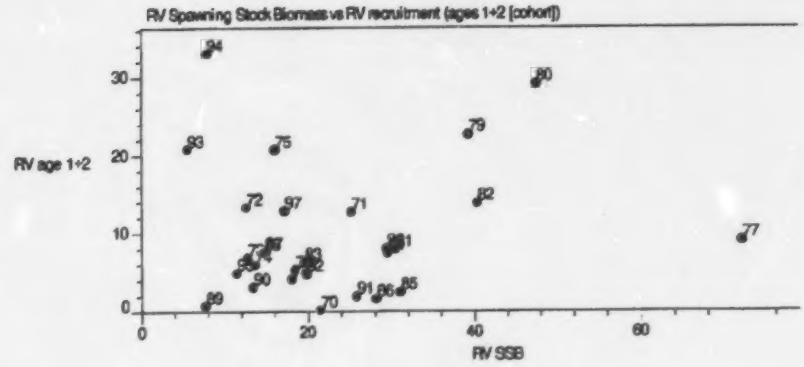


Figure 26a. Spawning stock biomass and age 1 recruitment in the subsequent year from this assessment. Labels are year-class.

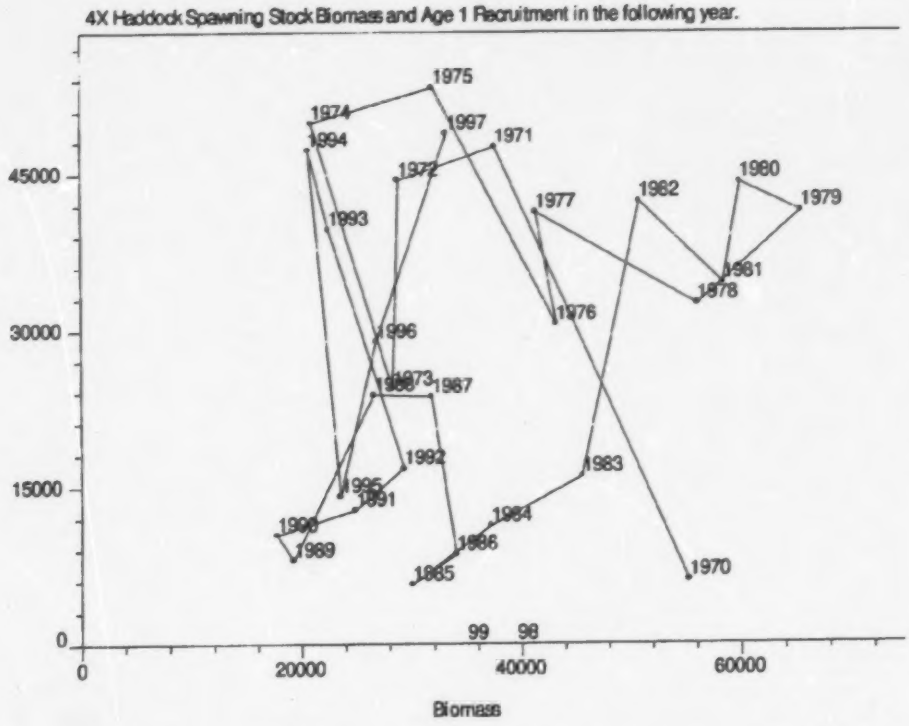


Figure 26b. Spawning stock biomass and age 1 recuitment in the subsequent year from this assessment. Labels are year-class.

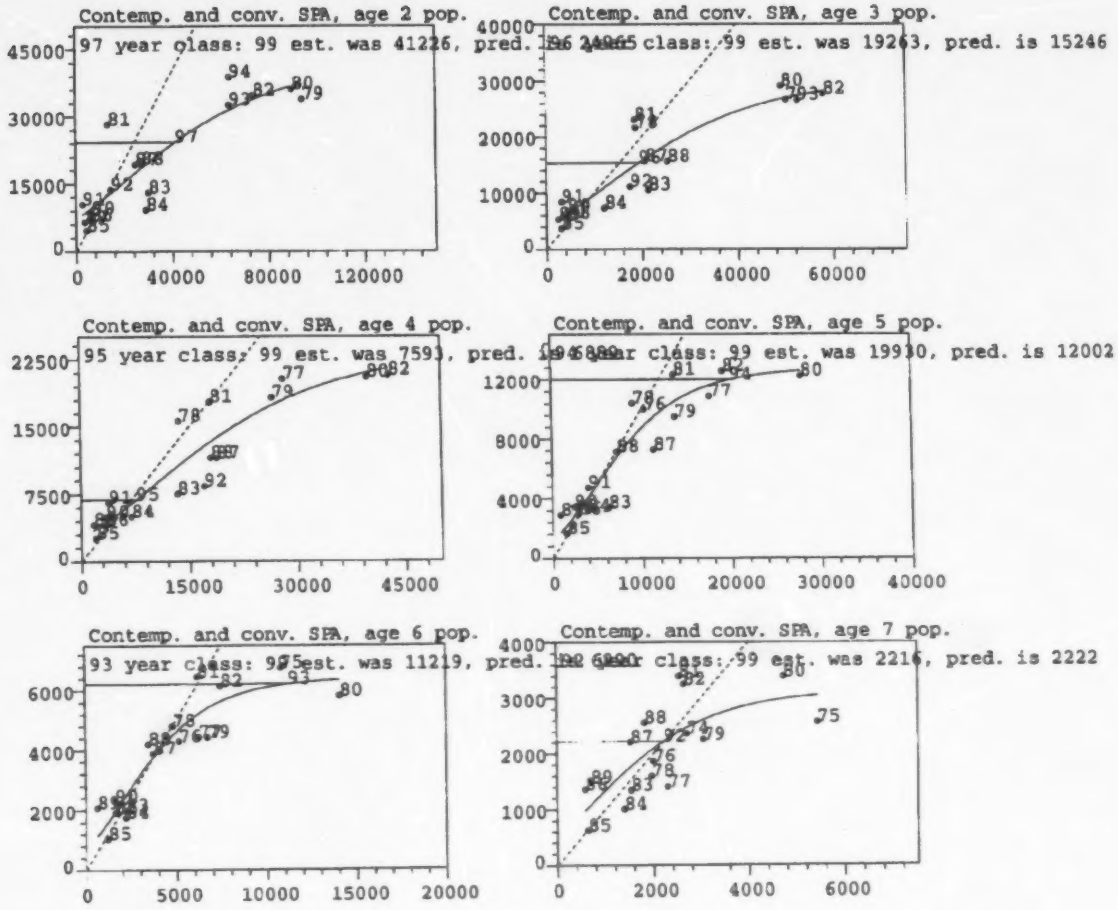

Contemp. and conv. SPA, age 2 pop.
97 year class: 99 est. was 41226, pred. is 15246
Contemp. and conv. SPA, age 3 pop.
Contemp. and conv. SPA, age 4 pop.
95 year class: 99 est. was 7591, pred. is 12002
Contemp. and conv. SPA, age 5 pop.
Contemp. and conv. SPA, age 6 pop.
93 year class: 99 est. was 11219, pred. is 2222
Contemp. and conv. SPA, age 7 pop.

Figure 27. Comparisons of contemporaneous and converged SPA estimates of population numbers at ages 2-7. The solid line is the Gompertz fit and the dashed line is unit slope. The label denotes the year-class.

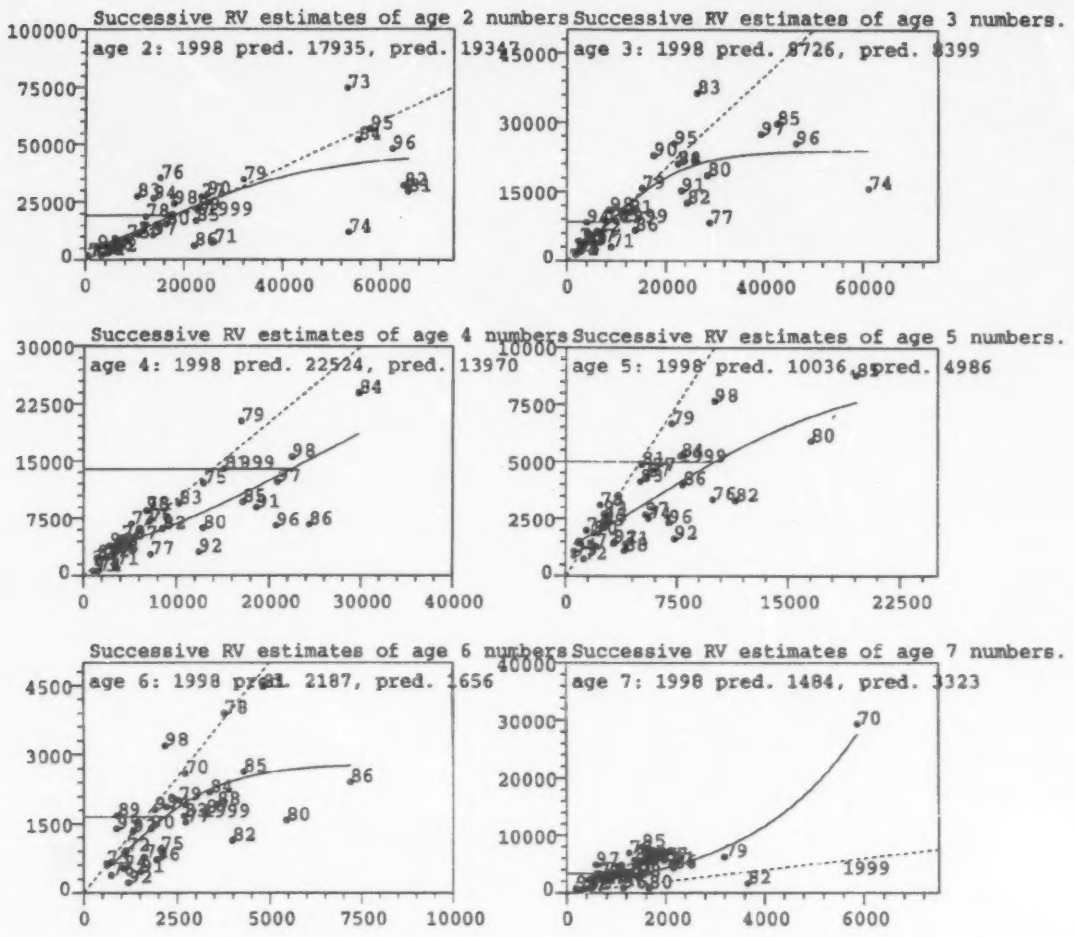

Successive RV estimates of age 2 numbers
age 2: 1998 pred. 17935, pred. 19347
Successive RV estimates of age 3 numbers.
age 3: 1998 pred. 8726, pred. 8399
Successive RV estimates of age 4 numbers
age 4: 1998 pred. 22524, pred. 13970
Successive RV estimates of age 5 numbers.
age 5: 1998 pred. 10036, pred. 4986
Successive RV estimates of age 6 numbers
age 6: 1998 pred. 2187, pred. 1656
Successive RV estimates of age 7 numbers.
age 7: 1998 pred. 1484, pred. 3323
1999

Figure 28. Comparison of q-adjusted RV survey numbers at age for the same cohort in the subsequent year (adjusted for natural mortality) for ages 2-7. The solid line is the Gompertz fit and the dashed line is unit slope. The label denotes the year-class.

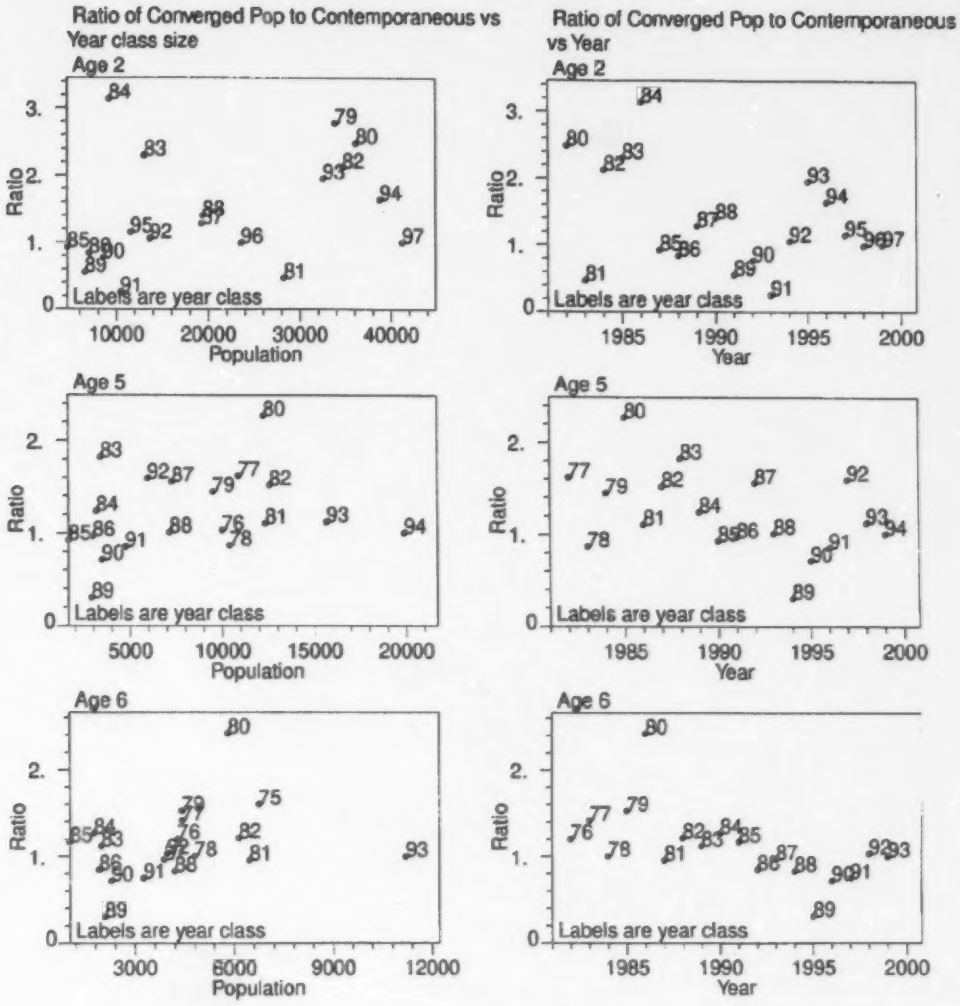


Figure 29. Plot of the ratios of contemporaneous to converged SPA population numbers at age against converged SPA population numbers (left) and against year (right) for ages 2, 5, and 6. The label denotes year-class.

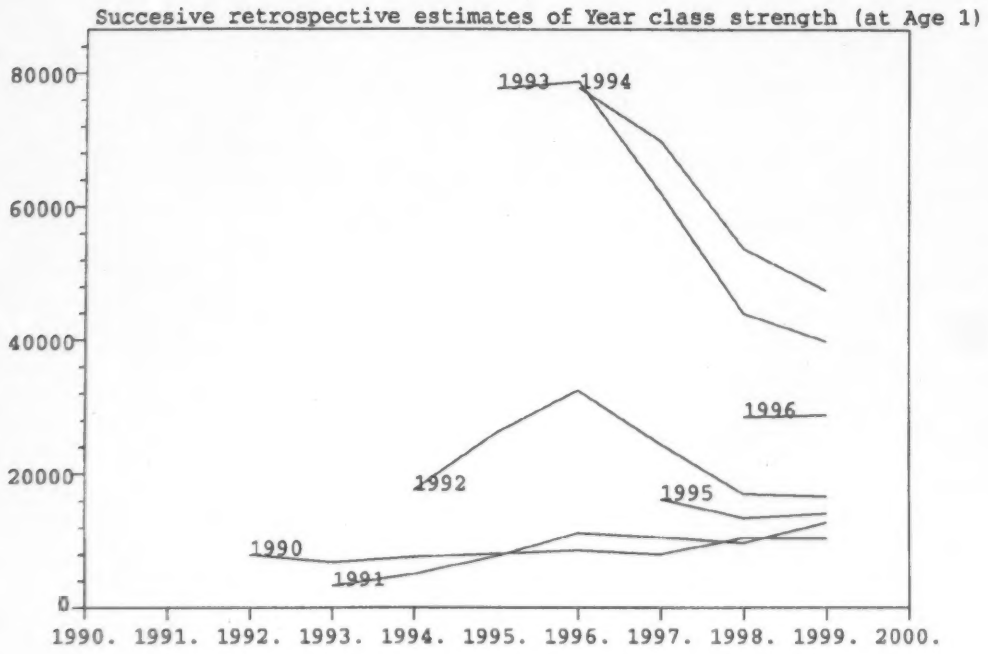


Figure 30. Successive retrospective estimates of age 1 population numbers for a year-class from retrospective analysis.

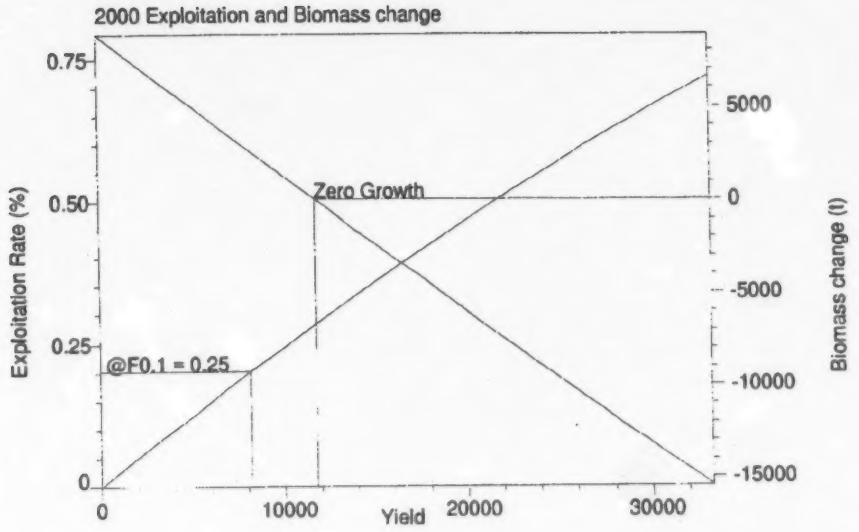


Figure 31. 4X Haddock projection showing trajectories of exploitation rate and change in spawning stock biomass at various levels of yield in 2000.

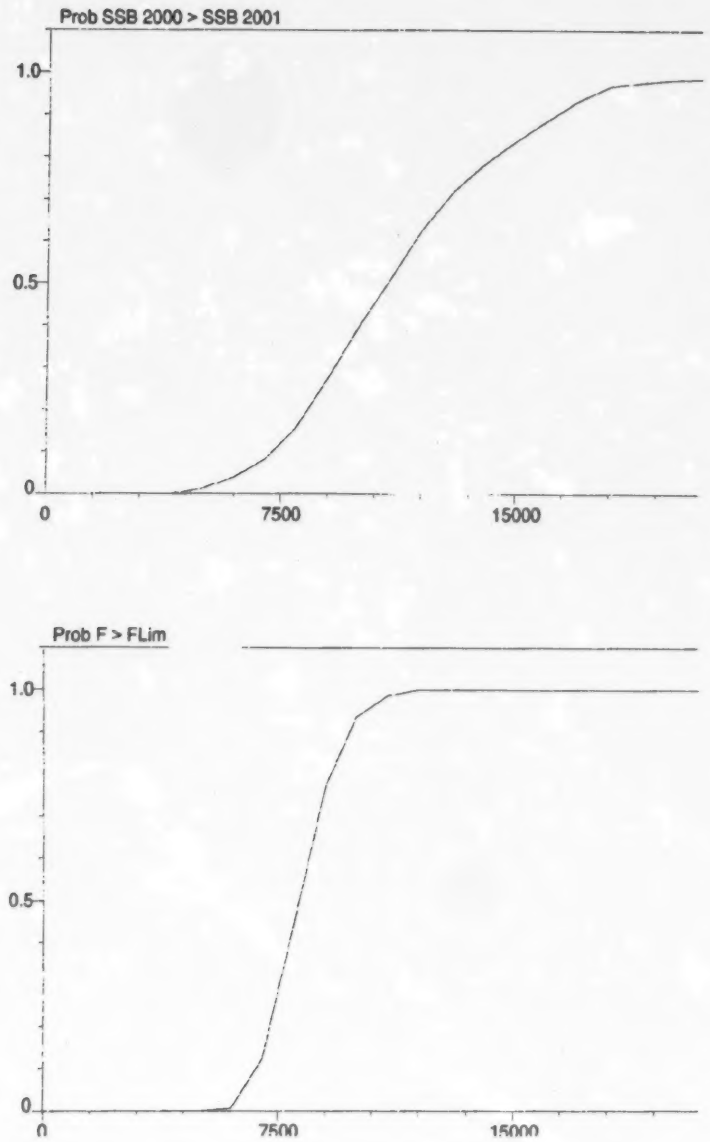


Figure 32. Probability that Spawning stock biomass will decrease, and F0.1 will be exceeded at various levels of yield in 2000 from 4X haddock projections.